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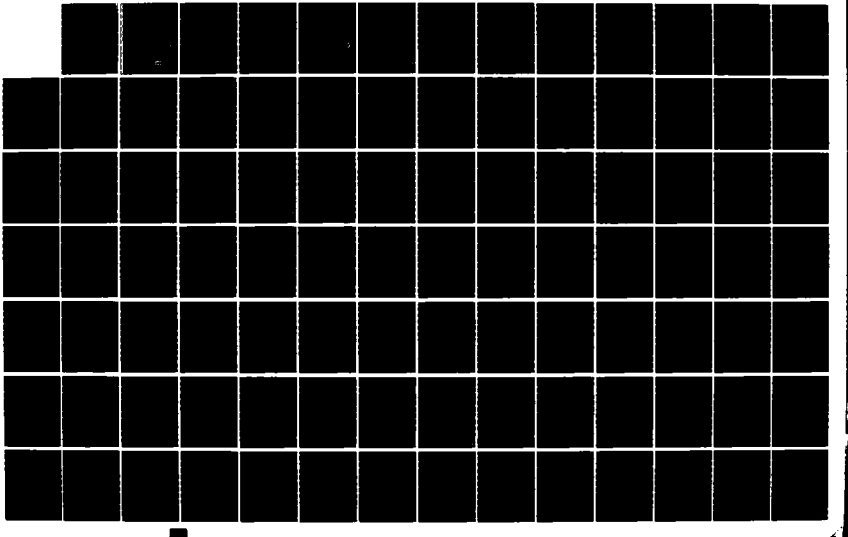

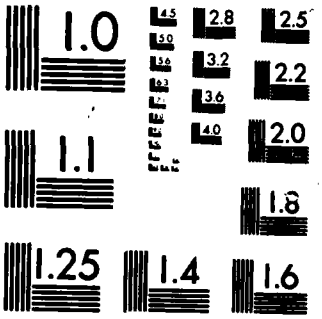

Fin Fish Seasonality and Utilization of Hampton Roads and the Entrance Channel

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for

The U. S. Army Corps of Engineers,
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Trawl, gillnet, and pound net sampling methods employed to assess abundance and distribution. Results presented in catagories of Bay spawners, River spawners and offshore spawners using bay as nursery. Also of interest is information presented on fish anomalies found in Elizabeth River samples.

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Introduction

This study of finfish seasonality and utilization of Hampton Roads and its entrance channels was commissioned by the U. S. Army Corps of Engineers to provide information necessary in the assessment of the environmental impact of Norfolk Harbor and channels deepeening project.

The primary objectives of the study were to determine the relative distribution and abundance of fish species in the study area (Fig. 1), and to describe their seasonal use patterns. With increasing sophistication, marine ecologists have come to the realization that a single year of study of seasonal phenomena provides a poor picture of events and processes. The two year duration of this study provides a somewhat clearer understanding of variability within the system. Additionally, where available, other sources of historic data have been incorporated. A companion study of catches by a pound net located off Lynnhaven have been particularly useful (Birdsong, et al, 1984).

Over the past decade several studies of fish abundance and distribution have been conducted in the general Hampton Roads area, most as a portion of the environmental impact assessment of one project or another. Most of these studies remain buried in the "gray literature" of limited circulation reports. Two of these which we have found to be the most useful in reviewing the available data are ~~the final~~ environmental assessment report ~~for the~~ Porstmouth Refinery, NUS

Corp. (1975) and a study of dredging effects in Hampton Roads edited by Priest (1981). We make no attempt to review these various studies here, but have referred to them where appropriate in the text.

Methods and Materials

Trawl sampling. Trawl stations were collected monthly from January 1982 through January 1984, excluding February 1982 and December 1983, at eight stations described below and shown in Figure 1 and Table 1. Each trawl station comprised three 10 minute tows with a 16 foot wide, semiballoon, otter trawl. The trawl carried a 1/4 inch mesh codend liner.

Catches were worked up on deck, when possible, and the bulk of the material discarded. Unusual species and voucher specimens were preserved in 10% formalin and placed in the fish collection of the Old Dominion Univeristy Department of Biological Sciences or the fish collection of the Virginia Institute of Marine Science.

All fishes were identified and counted. Standard length (SL) measurements to the nearest millimeter were taken on all species from each 10 minute tow as follows:

1. Less than 25 individuals of a species taken - all measured.
2. More than 25 individuals of a species taken -

20 randomly selected individuals measured along with the largest and smallest as selected by eye.

3. When the catch was composed of two distinct size classes of a species, each size class was treated separately.

Gillnet sampling. Eighteen gillnet samples using 600 feet of 6 foot deep sinking net were taken between March 1982 and October 1983 as shown in Table 1 and Figure 1. A station consisted of setting the net in the afternoon and picking it up the following morning. Over the course of the study several different nets and mesh sizes were used ranging from 2 inch stretch to 7 inch stretch mesh. Most sets were made with nets between 3 and 5 inch stretch mesh.

The precise location of the gillnet station varied from month to month, but was genreally located off Ocean View at approximately 36 56' N, 76 14' W in 20 - 24 feet of water.

The gillnets were the most highly selective gear used in this study and produced the smallest percentage of the total species taken by all gear types. We have not treated the gillnet data quantitatively but have used it to add to the list of species occurrences and as indicators of seasonality for those species favored by this gear type.

Pound net sampling. Sixteen pound net samplings were conducted between May 1982 and November 1983 (Table 1) at a pound net located just east of Lynnhaven Inlet at 36 55.3' N, 76 04.4' W (Figure 1). On each sampling day the entire catch

was examined and all species were indentified and counted. Where the abundance of a species was too great for enumeration, total poundage was taken. The log books of the poundnet operator, Mr. George Ross, provided additional data on the poundage of saleable species taken on each net pull during the period 1973 - 1981. These data have been employed in this paper to indicate seasonal abundance patterns in several commercially important species. The poundnet sampling program is reported on in more detail in a separate report (Birdsong, et al, 1984).

Description of trawl stations. (Fig. 1)

Station 1. Located approximately 5.5 nautical miles east of Cape Henry light house at 36 55.5' N, 75 54.7' W. Depth 55 - 65 feet; bottom smooth, composed of 55% sand, 40% silt, 5% clay. Salinity range during the study period 19.0 - 31.2 ppt, X = 26.5 ppt.

Station 2. Located approximately 2 nautical miles east of the Second Island of the Bay Bridge-Tunnel at 36 58.3' N, 76 04' W. Depth 36 - 45 feet; bottom nearly barren, composed of 98% sand and 2% silt. Salinity range 15.3 - 28.8 ppt, X = 23.3 ppt.

Station 3. Located just west of the First Island of the Bay Bridge-Tunnel at 36 58.2' N, 76 07.7' W. Depth 23 - 30 feet; bottom composed of silty sand with some large mussel beds. Salinity range 17.2 - 26.6 ppt, X = 22.0 ppt.

Station 4. Located approximately 3 nautical miles east of Fort Wool south of the shipping channel at 36 59.5' N, 76

13.2' W. Depth 22 - 28 feet; bottom composed of silty sand with occassionally heavy growths of the bryozoan Chrysia. Salinity range 13.7 - 22.8 ppt, X = 20.1 ppt.

Station 5. Located east of Craney Island landfill, west of the ship channel in the mouth of the Elizabeth River at 36 55' N, 76 20.7' W. Depth 25 feet; bottom of 70.8% silt, 16.7% sand and 6.6% clay. Salinity range 13.3 - 21.9 ppt, X = 18.1 ppt.

Station 6. Located in the main stem of the Elizabeth River off Lamberts Point, west of the ship channel at 36 52.3' N, 76 20.5' W. Depth 25 feet; bottom of 60.9% silt, 26.9% clay, 12.3% sand. Salinity range 12.8 - 21.7 ppt, X = 17.7 ppt.

Station 7. Located approximately 1 nautical mile up the Southern Branch of the Elizabeth River from its confluence with the Eastern Branch at 36 49.9' N, 76 17.5' W. Depth 45 feet; bottom composed of poorly sorted fine silt and littered with industrial debris. Salinity range 9.9 - 20.9 ppt, X = 16.1 ppt.

Station 8. James River approximately 5.5 nautical miles upstream of the James River Bridge, southeast of Mulberry Island and south of the ship channel at 36 03' N, 76 34' W. Depth 25 feet; bottom composed of poorly sorted coarse silt with some oyster reefs. Salinity range 6.8 - 17.9 ppt, X = 13.5 ppt.

Results

The trawl stations were clustered using the Dice Coefficient for presence/absence (Boesch, 1977), treating the data sets for 1982 and 1983 separately. The results of the clustering analysis are shown in Figure 2. For 1982 the bay stations 1 - 4 clustered together, with 1 and 3 most similar and 2 most dissimilar. Similarly, the riverine stations 5 - 8 clustered together, with the Elizabeth River main stem stations 5 and 6 most similar and the Southern Branch station 7 most dissimilar.

The results of the analysis on the 1983 data set differed somewhat from that on the 1982 data set. Bay stations 1, 3, and 4 clustered together similar to 1982, however station 5 at the mouth of the Elizabeth River showed a greater similarity to these bay stations than to the other riverine stations. Station 2 showed less similarity to the other bay stations than in 1982. Elizabeth River stations 6 and 7 and James River station 8 clustered together for 1983.

To facilitate analysis and discussion, the following subjective compromise of the two cluster analyses has been employed in pooling length frequency and seasonality data: stations 1 - 4; stations 5 - 6; station 7; and station 8. While neither cluster analysis strongly supports the isolation of stations 7 and 8, this was done to allow focus on the Elizabeth River, and particularly the Southern Branch.

Trawl data form the basic information source for this

study; however pound net and gill net data have contributed importantly to the analysis of seasonal occurrence and species abundance. Table 2 shows the number and percent of total fish species taken by gear type. Trawl collections account for slightly less than 70 percent of the species seen during the study and are, no doubt, biased toward smaller and more bottom oriented fishes.

Several species known to occur in abundance in the study area were not collected. These species, primarily members of the killifish family Cyprinodontidae, inhabit shore margins and are rarely taken in open water trawl collections.

Musick (1972) lists 209 species of marine estuarine and diadromous fishes as at least occassionally found in the Chesapeake Bay. Of these, 109 were considered by him to be sporadic or rare in occurrence. Only 27 estuarine and anadromous species, and 2 marine species were noted as occupants of the bay throughout their entire life cycle. The resident species are made up largely of small species inhabiting grass beds, oyster reefs and marsh fringes. None are of more than minor commercial importance and all are widely distributed.

During this study 104 species of fishes were taken. Tables 3 and 4 show months of occurrence and stations of occurrence for these species. The most abundant species at each of the 8 trawl stations, and their rank among stations, is given in Tables 5 through 12.

For purpose of discussion we have categorized users of

the estuary into: bay spawners, rivers spawners, and species spawning outside the bay but using the estuary as nursery grounds. Some two dozen species which make significant use of the Chesapeake estuary have been singled out for discussion, most because of their abundance, but a few because of their rarity. Our coverage of the following species is not even, but emphasizes those species taken in abundance during this study.

Bay Spawners

Ten species of bay spawners are here discussed. Several other species of fishes may occassionally spawn in the bay (e.g. Menticirrhus spp. and Sciaenops ocellata according to Olney, 1978), but little is known as to the extent of their spawning use.

Anchoa mitchilli (bay anchovy). The bay anchovy was the most abundant and ubiquitous species taken during this study. A. mitchilli was collected during every month of the study and was somewhat more abundant at river stations than at bay stations and in winter than in summer.

Olney (1978) found eggs of A.. mitchilli to compose 89 percent of all fish eggs taken during the months of spawning. During his study, concentrations never fell below 320 eggs/10 m and to reached as high as 1400/10 m in August 1973. The spawning period for A. mitchilli appears to begin and end abruptly. An identical pattern was found in 1982 and 1983 in a companion plankton study to the report. Spawning apparent-

ly occurs throughout the Chesapeake Bay estuary with most eggs taken between 15 and 27 ppt salinity (Olney, 1978).

Cynoscion regalis (weakfish). The weakfish was the fourth most abundant species in the study area. Existing life history information for C. regalis has been reviewed by Chao and Musick (1977).

Weakfish apparently spawn in and near the mouth of Chesapeake Bay (Hildebrand and Schroeder, 1928; Joseph, et al, 1964a; Olney, 1978). Spawning occurs May to September with peak spawning mid-May to mid-June (Hildebrand and Schroeder, 1928), however, Olney (1978) reported large numbers of C. regalis eggs in the lower Chesapeake Bay in August of 1971.

Few young-of-the-year (YOY) smaller than 40 mm SL were collected at the Bay stations (Figs. 3 and 4), the young apparently moving into the rivers soon after hatching. Young of the year were first recorded at the Elizabeth River stations in small numbers in May (Fig. 7) and became abundant in July (Figs. 5, 7 and 8).

Two spawning pulses appear to be present based on the occurrence of YOY less than 35 mm SL at the Elizabeth River stations. This phenomenon was especially pronounced in 1983 (Figs. 6 and 8) where a YOY mode around 20 - 50 mm SL first appears in July and again in September. Merriner (1976) found that female C. regalis in North Carolina waters appear to spawn in two pulses, with the majority of the eggs spawned in May or June and a second and smaller spawn in July or

August.

The YOY apparently begin moving out of the river in October with the larger individuals leaving first. All C. regalis have left the river by the end of December.

Yearling trout appeared at both bay and river stations in May. Larger trout of year class 1 and older move into the Chesapeake Bay in March and are abundant in April in pound net catches. These large trout (greater than 200 mm SL) largely escaped our trawl catches. It appears then, from our data, that returning yearlings move back into the Bay slightly later than older weakfish.

Pogonias cromis (black drum). Black drum spawn in the bay mouth in April and May. Joseph, et al (1964a) reported large numbers of black drum eggs west of Cape Charles. Running ripe adults are caught in large numbers off Kiptopeke in April. By the end of the run in early June all fish taken are spent. The dearth of larvae in the area led Joseph, et al (1964a) to speculate that the bay was a marginal spawning area. Juveniles are found in small numbers in brackish and fresh tidal waters in the bay (Frisbie, 1961).

Bairdiella chrysoura (silver perch). While few silver perch were taken during this study the species is present in the estuary from April to December and most abundant from August to October (Chao and Musick, 1977). Hildebrand and Schroeder (1928) reported ripe silver perch in deep waters of the bay in May. Silver perch move out of the bay and southward in winter (Chao and Musick, 1977).

Tautoga onitis (tautog). Only four tautogs were taken during this study, however, it is a common species in the lower bay from December through June. The preferred habitat of this species; around rocks, pilings, and other underwater structures, makes capture by trawls unusual. Olney (1978) reported the collection of T. onitis eggs in the bay mouth in May and July, and suggested that the sparsity of eggs and larvae may indicate that the Chesapeake Bay is the southern limit of tautog spawning. Cooper (1965) reported that juveniles use grass beds as nursery grounds. One of us (Birdsong) has taken juvenile tautogs among patches of sea lettuce (Ulva) in one meter depth in the Lynnhaven estuary.

Rachycentron canadum (cobia). Joseph, et al (1964b) reported the spawning of cobia in the lower Chesapeake Bay in the vicinity of the Virginia Capes. Cobia eggs were collected from June through August, with a peak in July. Juvenile cobia are occassionally taken in Chesapeake Bay and were reported from the lower York River by Joseph, et al (1964b); however, little is known of their ecology.

Peprilus alepidotus (harvestfish). Olney (1978) collected larvae of this species throughout the lower bay in August and felt that the small size of the larvae and their distance from the bay mouth indicated a spring and early summer spawning period in the Chesapeake Bay and he noted that the juveniles are frequently associated with jellyfish.

Symphurus plagiusa (blackcheek tonguefish). The blackcheek tonguefish was ubiquitous in the study area, but not in

abundance at any stations. There is limited evidence of spawning in the bay mouth (Olney and Grant, 1976). Schauss (1974) reported metamorphosed juveniles of S. plagiusa in Lynnhaven Inlet on a muddy-sand bottom.

Pseudopleuronectes americanus (winter flounder). This species was rarely taken during this study, apparently being more abundant in the upper bay than in the lower bay (Musick, 1972). Spawning of P. americanus apparently takes place throughout the bay (Olney, 1978) from December through May with a peak in March. Juveniles remain in the Bay until they are 2 + years old (Frame, 1974) moving to deep water during colder months (Mc Cracken, 1963).

Trinectes maculatus (hogchoker). Hogchokers apparently spawn over a wide area of Chesapeake Bay and were reported as a major component of the egg and larvae collections of Olney (1978). He reported the capture of eggs from June through September, with peak egg abundance in August. Larvae and juveniles move up into the lower salinity waters of rivers (Dovel, et al, 1969) and overwinter in the bay and lower reaches of the rivers.

River Spawners

Of the eight species of anadromous river spawners discussed below, all but two, the white perch and the gizzard shad, spend a major portion of their life cycle outside the bay and pass through the bay mouth on their way to the spawning grounds in the tributaries. Three of these species,

the Atlantic sturgeon, American shad, and the striped bass, are found today in smaller numbers than in former times. Causes for these declines are uncertain, but most likely involve degradation of the upstream spawning grounds and overfishing.

Acipenser oxyrhynchus (Atlantic sturgeon). During this study only three Atlantic sturgeon were seen, all juveniles taken from a single gillnet set in April 1982 off Ocean View. The species is endangered and in low abundance in the Chesapeake Bay. Adults migrate into the major Chesapeake bay tributaries in March and April (Vladykov and Greeley, 1963) where spawning takes place in fresh or brackish water (Dees, 1961). Juveniles may remain in estuarine waters until 3 - 5 years of age (Vladykov and Greeley, 1963). Little is known of the larval ecology.

Alosa aestivalis (blueback herring). This species passes through the lower bay in spring from February through May with the peak run in April of most years (Hildebrand and Schroeder, 1928), however, during this study the peak run was in February and March. Young of the year apparently leave the bay in winter, but some overwinter in deeper bay waters (Hildebrand, 1964). Blueback herring were taken at all trawl stations but were most abundant in the main stem of the Elizabeth River.

Alosa pseudoharengus (alewife). The spawning migration usually begins in late February to early March, usually slightly ahead of the blueback herring and American shad

(Hildebrand and Schroeder, 1928). Spawning takes place far upstream in small tributaries. Young of the year mostly leave the bay by winter, but some may overwinter in deeper bay waters (Hildebrand, 1964).

Alosa sapidissima (American shad). The spawning run of the American shad peaks in March and April in the Chesapeake Bay. Spawning takes place in the upper tributaries where the young nursery until fall when most leave the bay (Hildebrand, 1964).

Alosa mediocris (hickory shad). The spawning run for hickory shad occurs in the lower bay in March and April in the Chesapeake Bay. Spawning apparently takes place in freshwater tributaries, however, no observations of spawning adults have been reported (Hildebrand, 1964). Young hickory shad apparently leave the spawning area in late summer to fall (Mansueti, 1962).

Dorosoma cepedianum (gizzard shad). The gizzard shad spends its entire life cycle in brackish and fresh water and is common in the bay proper only in fall and winter. Spawning takes place in freshwater in early summer and the young remain in freshwater (Hildebrand and Schroeder, 1928).

Morone saxatilis (striped bass). The striped bass, formerly abundant in the Chesapeake Bay, is presently in a state of serious decline. Only five specimens were taken during this study. Adults congregate around the bay mouth in winter and move into freshwater habitats of rivers in April and May where spawning occurs (Hardy, 1978). In the

Chesapeake Bay tributaries, larval nursery areas are the same as the spawning areas. Juveniles remain in low salinity waters and move downstream during their second summer (Rinaldo, 1971). Striped bass apparently remain in the bay for their first 3 - 4 years of life.

Morone americana (white perch). White perch were commonly taken in our trawls only at the James River stations (station 8). While found in the bay, this species prefers lower salinity waters. Spawning occurs in freshwater from late March to June (Mansueti, 1964). Nursery areas are the same as spawning areas and as development proceeds there is a downstream movement (Rinaldo, 1971).

Fishes which spawn offshore and use the Bay and Tributaries as Nursery Grounds

Brevoortia tyrannus (menhaden). Menhaden were taken at all stations and were especially abundant in winter and spring. Spawning occurs in shelf waters off the Chesapeake Bay mouth (Massmann, et al, 1962). McHugh, Oglesby, and Pacheco (1959) indicate a fall and spring spawning peak off Chesapeake Bay. Larvae move into the bay in May and June and in November (Dovel, 1971). Juveniles use brackish to freshwaters as nursery areas and may be found as far as 56 km upstream from brackish water (Massmann, 1954). Juveniles move out of the estuary into coastal waters late in their first summer (June and Chamberlain, 1959), but some overwinter in the bay. Menhaden were taken in the bay during

every month of the present study.

Leiostomus xanthurus (spot). The spot was the most abundant fish taken by all three gear types, the ubiquitous Anchoa mitchilli excepted. The distribution, seasonality, diet, and growth of L. xanthurus in the Chesapeake Bay have been the subject of many studies over the past 60 years. Notable among these are those of Hildebrand and Schroeder (1928), Pacheco (1962a and 1962b), and Chao and Musick (1977). Growth and diet studies on spot from a variety of Gulf and Atlantic estuaries are summarized by Chao and Musick (1977).

Figures 9 - 11 show the size frequency distributions for trawl captured spot for the pooled data from bay stations 1 - 4.

Young-of-the-year first become abundant at the bay stations in May, at lengths of about 10 to 25 mm SL. These young are presumably spawned offshore during late autumn through early spring (Powles and Stender, 1978). The YOY fish appear to move through the lower bay rapidly and few are taken in trawls in June and July (Figs. 9 and 10).

Adult spot become abundant in the bay in August (Fig. 10) moving in from coastal waters. Larger YOY and yearlings also begin to move out of the rivers into the bay in late summer. This assemblage forms a bimodal, but continuous size distribution as seen in Figure 10, September 1982. In October the yearling and older spot begin to exit the bay for offshore waters. During both years of this study no spot

were taken at any bay station in February and March.

Size distribution of spot in the main stem of the Elizabeth River (Figs. 12 - 14), the Southern Branch of Elizabeth River (Figs. 15 - 17), and the lower James River (Figs. 18 and 19) are shown below. Young-of-the-year-spot appear at the river stations shortly after they enter the bay. Growth of YOY fishes is rapid through September when they have reached a size of 90 - 170 mm SL. Chao and Musick (1976) reported a September YOY size range of 70 - 185 mm total length (TL) in the lower Chesapeake Bay and York River, Virginia and Pacheco (1957, in Chao and Musick, 1977) reported September YOY of 135 - 185 mm TL in the lower Chesapeake Bay and York River. Pacheco (1962a) noted that YOY spot taken in pound net catches had a modal length 40 mm larger than those taken in trawl hauls. We assume from this that the largest YOY individuals are more successful at avoiding the trawl, and consequently, in late summer and early fall the YOY size distribution, as indicated by our catches, is biased toward smaller sizes.

Size bias not withstanding, it appears that the larger YOY individuals start to move out of the rivers before the smaller, as evidenced by a decrease in modal size in October at all river stations. As can be seen in Figure 16, some YOY fish, albeit a small number, overwinter in the rivers. Overwintering of YOY in the York River was reported by Chao and Musick (1977).

Simultaneous with the entry of YOY spot into the rivers,

yearling spot approximately 90 - 180 mm SL, return to the rivers. These are represented by the second mode in Figure 12, May 1982 and Figure 18, May 1982, for examples. In the main stem of the Elizabeth River in May 1982 (Fig. 12) a third mode of fish around 175 mm SL appears to be present. Yearlings are present at the river stations by April and absent by October.

Among the river stations, station 7 in the Southern Branch was unique in that yearling spot were abundant only during June 1982.

Micropogonias undulatus (Atlantic croaker). The Atlantic croaker was taken in abundance at all stations and by all gear types from March through November. Croakers provide the basis for an important recreational and commercial fishery in the lower Chesapeake Bay; however, the population exhibits large fluctuations in abundance (Haven, 1957; Massman and Pacheco, 1960; Joseph, 1972). The fluctuations may largely result from annual differences in the severity of winter temperatures inshore in the nursery ground as well as offshore on the spawning ground (Joseph, 1972; Chao and Musick, 1977; Norcross and Austin, 1981).

Spawning of the Chesapeake croakers apparently occurs in the near shelf waters east and southeast of the Chesapeake Bay mouth (Pearson, 1941; Haven, 1957; Grosslein and Azarovitz, 1982). Young of the year croaker appear at river stations in September and October (Figs. 23, 26, 28, 29). During the present study individuals less than 25 mm SL were

seen during every month except July and August. Similar observations by Haven (1957) and Chao and Musick (1977) suggest a spawning season spanning most of the year; however, Morse (1980) disputed this on the basis of gonad observations, and postulated a spawning period of September through December, with a peak in October. He suggested that the presence of small fish in the estuary during most months may be the result of no overwinter growth or sampling bias due to differential size distribution or trawl avoidance. White and Chittenden (1977) also suggest an October peak in spawning with December as the postulated end of spawning.

Neither sampling bias, differential size distribution, nor trawl avoidance appear relavant to the explanation of the occurrence of croaker less than 20 mm SL in May and June. Only a lack of winter growth would appear to bear on the question if we assume a December end to spawning. The predominance of a single mode of small croaker (15 - 40 mm SL) at all river stations during winter and spring supports the proposition of little or no winter growth. However, the presence of two modes of small fish, about 25 mm SL and 75 mm SL in the Southern Branch in June 1983 (Fig. 27) and 3 modes in the mainstem of the Elizabeth River in the same month (Fig. 24) and in June, 1982 (Fig. 22) is difficult to reconcile with a limited spawning period around October. A similar intermediate mode not easily assigned to young of the year or yearlings was seen by Chao and Musick (1977) in the York River in 1972 and 1973.

Young-of-the-year fish grew rapidly from June through the summer at the river stations and reached a length of 100 - 240 mm SL by September. Croakers started to move out of the river stations in September with yearlings leaving first and YOY following in October and November.

Adult or near adult croakers (greater than 130 mm SL) occur in the lower Chesapeake Bay from March through November. Pound net catches indicate two pulses of abundance, one in Spring, March through May, and the another in September. The spring pulse is presumed to be year class 1 and older fish returning to the bay from offshore. The September pulse appears to be made up of a mixture of age classes but dominated by YOY fish. Our trawl collections in both 1982 and 1983 did not record the spring croaker run at the bay stations (Figs. 20 and 21), however, the fall run was sampled during both years. While the sampled spring run tends to comprise slightly larger fish, we find if difficult to accept gear avoidance as the sole cause for the virtual absence of croaker in our bay trawls in the spring. We have no information bearing on this phenomenon, however it may be the result of some difference in the behavior of the year class 1 and older fishes returning to the bay from the YOY dominated groups leaving the bay in the fall.

Sciaenops ocellata (red drum). Red drum apparently spawn outside the Chesapeake estuary during the fall months (Mansueti, 1960), however, information concerning spawning and the larval stages is scarce. Mansueti (1960) speculates

that planktonic larvae are carried into the estuary in the salt wedge in the fall and descend to the ocean in early winter. Schauss (1974) took 64 young red drums ranging in length from 9 to 39 mm in Lynnhaven Bay from July to mid-October, thus demonstrating that at least some spawning occurs as early as July. Mansueti (1960) states that small Sciaenops have never been taken in Chesapeake Bay during the winter months (December to February). During the present study two small S. ocellata were taken in January, one (62 mm SL) at station 6 in 1983, and another (54 mm SL) at station 3 in 1984. It appears that at least some young-of-the-year S. ocellata overwinter in the bay.

Urophycis regia (spotted hake). Spotted hake were abundant at all river stations and only slightly less abundant at bay stations. Spawning apparently takes place offshore between September and November (Barans, 1972). Fish of 30 - 90 mm SL, young of the year according to Barans (1972), enter the bay from December through May (Figs. 32 and 33) and the rivers at approximately the same time (Figs. 34 - 37).

Yearling and older fish enter the bay from March through May and remain through December. During most months year class modes are difficult to discern, being readily apparent only during months when YOY are entering the bay system. Maximum abundance of U. regia is reached in April and May, both in the bay and in the rivers.

Urophycis chuss (red hake). The red hake is abundant

only in the bay mouth at trawl station 1. Spawning occurs offshore primarily in spring and summer (Hardy, 1978). Juveniles from 50 - 200 mm SL enter the bay in late winter and early spring and leave by June.

Paralichthys dentatus (summer flounder). Summer flounder were common at all stations, but generally more abundant at bay stations than at river stations. In winter, adult P. dentatus are found offshore and mostly in waters between 70 - 155 m in depth. In summer there is a general shoreward movement of the populations (Byrne and Azarovitz, 1982).

Spawning occurs offshore in autumn, with peak spawning off the Virginia Capes falling around October and November (Smith, 1973). Young of the year were first taken at our bay stations in July at about 60 - 100 mm SL (Figs. 38 and 39). These small flounders must have been present at least a month earlier because we took YOY of similar size at the river stations in June (Figs. 40 and 41). It appears that the YOY move through the lower bay rapidly and concentrate in the rivers in early summer.

Year one and older fish were first caught in March and April, and remained in the rivers until September - October when they began to move out. The yearlings and older fish remain- ed in the bay until December, after which none were taken. It is likely that three year fish (about 370 mm SL according to Byrne and Azarovitz, 1982) and older moved out to the spawning grounds earlier (September to October), but because of gear avoidance we have little information on these

larger size classes.

Young of the year remain in the rivers through December (Fig. 41) and then apparently move out into the bay where they over winter. Some P. dentatus were taken in the bay during every month of the year (Figs. 39 and 40).

Elizabeth River

We have singled out the Elizabeth River for special discussion because of its recognition as one of the most heavily polluted areas in the Chesapeake Bay estuary. In addition to a heavy sediment burden of several heavy metals, very high concentrations of a variety of polynucleated aromatic hydrocarbons (PAH's) contaminate the sediments throughout much of the Southern Branch (R.W. Alden III, pers. comm.). We collected over the two years of this study at three stations in the Elizabeth River, two in the main stem (stations 5 and 6) and one in the Southern Branch (station 7). Table 13 shows sediment concentrations of PAH's at three sites in the Elizabeth River provided by R. W. Alden, III from unpublished data. Our station 6 encompasses site G and our station 7 encompasses sites L and M of Table 13. It is apparent from these data that sediments in the vicinity of station 7 in the Southern Branch are considerably more polluted with PAH's than sediments in the main stem at stations 5 and 6.

In spite of the heavy industrialization of the Elizabeth River, many fishes utilize it as a nursery area, and some for

spawning. Work done by Ecological Analysts, Inc. in 1979 (as cited in Priest, 1981) shows the presence in the Southern Branch of eggs or larvae of gizzard shad, bay anchovy, tidewater silverside, Atlantic silverside, white perch, gobies, and hogchoker. Hedgepeth, et al (1981) indicate the probability of some spawning in the upstream tidal creeks of the Elizabeth River by blueback herring, alewife, American shad, and striped bass.

In our trawl studies, the Elizabeth River mainstem stations were among the most prolific producers of fishes. Station 6 (Table 10) ranked first in the abundance of the bay anchovy, Atlantic croaker, spotted hake, weakfish, blueback herring, Atlantic silverside, and silver perch. This station was also the second largest producer of spot and the largest producer of all species combined.

Station 7 in the Southern Branch, located less than 4 miles upstream from station 6 and under a similar salinity regime, differed markedly in the abundance of fishes (Table 11) and had the lowest species diversity of any station. Compared to station 6, abundance at station 7 was: bay anchovy 10%, summer flounder 25%, spotted hake 35%, hogchoker 46%, and spot 55%. Croaker and weakfish show no similar reductions in abundance.

The reduction in the number of spot at station 7 does not appear to be spread evenly across the size classes. Comparing figures 15 - 17 with 12 - 14 it is apparent that

the Southern Branch is receiving a smaller number of returning yearlings than is the main stem. Comparisons of figures 7 - 8 with 5 - 6 of the weakfish and figures 25 - 28 with 22 - 24 of the Atlantic croaker suggest some avoidance of the Southern Branch by yearling fishes of these two species as well. Chao and Musick (1977) noted a tendency for YOY of all three of these species to be distributed farther upstream in the York River. We cannot say whether the apparent lower abundance of yearlings in the Southern Branch is salinity related, however, on most sampling days the salinity at station 7 was within 1 ppt of the salinity in the main stem. The most striking physical difference between station 7 and the main stem was the pollutant load in the sediments.

The most remarkable feature of the Southern Branch fish fauna is the high rate of occurrence of diseased and anomalous individuals, especially among the benthic species. Tables 14 and 15 summarize some of the observations on diseased fishes. More observations than those shown here have been made and will be reported on separately. The area of the river where anomalies occur coincides with the area showing heavily contaminated sediments. The incidence of anomalies at stations 5 and 6 in the main stem was at a level similar to that seen at the bay stations and at a comparison station in the Western Branch. Anomalous fishes are frequently encountered upstream from station 7, however (William Hargis, pers. comm.).

Fisheries

Recreational Fishing: Thimble Shoal Channel impinges on the primary recreational fishing grounds in the lower Chesapeake Bay. No data exists on recreational fishing effort or catch levels for the area, however, the level is high. Recreational fishing effort is focused on the area around the Chesapeake Bay Bridge-Tunnel. The author has counted from aerial observations on a single pass, over 500 recreational vessels fishing within 1/4 mile of the bridge-tunnel during peak fishing season in late spring.

While some 30 species of fishes are occassionally taken by recreational fishermen, the majority of the recreational effort is directed toward the seven species shown below.

Species	Months of Occurence	Peak Abundance
bluefish	April - October	April, May, October
weakfish	March - October	April, May, June
spot	August - October	September, October
summer flounder	April - November	September, October
croaker	March - October	March - May, September
tautog	December - June	May, November
black sea bass	June - November	July

Commercial Fishing: commercial fishing for finfish species in the study area is primarliy by pound nets, gillnets, and purse seines. Table 16 gives the total landings of commercial fin fish in NMFS area 311 for 1982 - 83. Area 311 excludes the rivers. Figure 42. shows the seasonal distribution of catch for six of the leading commercial species. For these species, catches are primarliy

between April and November with some summer drop off between June and August.

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Table 1: Sampling schedule and number of stations by gear type for the period January 1982 - January 1984.

Date		Stations		
		Trawl	Gillnet	Pound Net
1982	January	8	1	
	February			
	March	8	1	
	April	8	1	
	May	8	2	1
	June	8	1	2
	July	8	1	1
	August	8	1	1
	September	8	1	1
	October	8	1	1
	November	8	1	1
	December	8		
1983	January	8		
	February	8		
	March	8	1	
	April	8	1	1
	May	8	1	1
	June	8	1	1
	July	8	2	2
	August	8	1	1
	September	8		1
	October	8	1	1
	November	8		1
	December			
1984	January	8		

Table 2. Number and percent of total fish species taken by gear type.

Gear Type	Species collected by gear type	Species unique to gear type	Percent of all species Collected	Percent of all species unique to gear type
Trawl	73	20	69.5	19.0
Gillnet	32	3	30.0	2.9
Poundnet	78	27	74.3	25.7

Table 3. Month(s) of occurrence in the catch (x = present; * = months of greatest abundance).

Species	Month(s) of Occurence											
	J	F	M	A	M	J	J	A	S	O	N	D
Lampreys												
Petromyzon marinus (sea lamprey)			x	x								
Requieum Sharks												
Carcharhinus obscurus (dusky shark)						x			x			
Carcharhinus plumbeus (sandbar shark)							x	x				
Mustelus canis (smooth dogfish)					x	x	x	x	x	*	*	
Dogfish Sharks												
Squalus acanthias (spiny dogfish)				x								
Skates												
Raja eglanteria (clearnose skate)				x	x	x	*	x	x	x	x	
Raja erinacea (little skate)				x								
Stingrays												
Dasyatis americana (s. stingray)				x				x				
Dasyatis centroura (roughtail stingray)										x		
Dasyatis sabina (Atl. stingray)							x			x		
Dasyatis sayi (bluntnose stingray)					x	x	x	*	x	x		
Gymnura micrura (smooth butterfly ray)								x				
Eagle Rays												
Myliobatis freminvillei (bullnose ray)						x	*	x	x	x		
Rhinoptera bonasus (cownose ray)					*	x	x	x	x	x		
Sturgeons												
Acipenser oxyrhynchus (Atl. sturgeon)			x									
Tarpons												
Elops saurus (ladyfish)									x	*		
Megalops atlanticus (tarpon)									x			
Eels												
Anguilla rostrata (American eel)	x			*	x	x	x	x	x	x		x
Conger oceanicus (Conger eel)		x										
Myrophis punctatus (speckled worm eel)	x											
Herrings												
Alosa aestivalis (blueback herring)	x	*	*	x								
Alosa mediocris (nickory shad)			x									
Alosa pseudoharengus (alewife)	x	x		*								
Alosa sapidissma (American shad)	x	x	*	*	x	x						
Brevoortia tyrannus (Atl. menhaden)	*	*	*	*	x	x	x	x	x	x	x	x
Dorosoma cepedianum (gizzard shad)	*			x		x	x			x	x	
Opisthonema oglinum (Atl. thread herring)											x	

Table 3. Cont.

Species	Month(s) of Occurence											
	J	F	M	A	M	J	J	A	S	O	N	D
Anchovies												
Anchoa mitchilli (bay anchovy)	*	*	*	*	x	x	x	x	x	x	x	
Lizardfishes												
Synodus foetens (inshore lizardfish)								x	*	x		
Carps and Minnows												
Cyprinus carpio (common carp)			x	x								
Toadfishes												
Opsanus tau (oyster toadfish)	x	x	x	x	x	*	*	x	x	x	x	x
Clingfishes												
Gobiesox strumosus (skillet fish)	x			x						x		
Goosefishes												
Lophius americanus (goosefish)			x	x								
Codfishes												
Gadus morhua (Atl. cod)				x								
Merluccius bilinearis (silver hake)	*	*	*	*	x		x					
Urophycis chuss (red hake)	x	*	*	*	x	x				x	x	x
Urophycis regia (spotted hake)	x	x	*	*	*	x	x	x	x	x	x	x
Cusk-eels												
Ophidion marginatum (striped cusk-eel)				*	x	x	x	x	x	*	x	x
Killifishes												
Fundulus majalis (striped killifish)				x								
Silversides												
Menidia menidia (Atl. silverside)	*	*	x				x				x	x
Pipefishes and Seahorses												
Hippocampus erectus (lined seahorse)	x	x	x	x								
Syngnathus floridae (dusky pipefish)				x								
Syngnathus fuscus (northern pipefish)	x	x		x	x		x	x	x	x	x	x
Syngnathus louisianae (chain pipefish)								x				
Temperate Basses												
Morone americana (white perch)		x		*	x	x	*	x	x	*	x	x
Morone saxatilis (striped bass)	x		x								x	
Sea Basses												
Centropristis striata (black sea bass)				x		x	x	x	x	x	x	x
Mycteroperca microlepis (gag)						x			x	x		
Bluefishes												
Pomatomus saltatrix (bluefish)			x	*	*	x	x	x	x	*	x	

Table 3. Cont.

Species	Month(s) of Occurence											
	J	F	M	A	M	J	J	A	S	O	N	D
Cobias												
Rachycentron canadum (cobia)										x		
Remoras												
Echeneis naucrates (sharksucker)							x	x	x	x		
Jacks												
Caranx chrysos (blue runner)									x	x		
Caranx hippos (crevalle jack)									*	*		
Oligoplites saurus (leatherjacket)							x	x				
Selene vomer (lookdown)									x	x		
Selene setapinnis (Atl. moonfish)						x	x	x	*	x		
Seriola dumerili (greater amberjack)								x				
Seriola zonata (banded rudderfish)							x					
Trachinotus carolinus (Florida pompano)						x	x	x	x	x		
Grunts												
Orthopristis chrysoptera (pigfish)						x	x	x	x	x		
Porgies												
Archosargus probatocephalus (sheepshead)					x							
Stenotomus chrysops (scup)					x	x	x	*	*	x	x	
Drums												
Bairdiella chrysoura (silver perch)				x	x	x	*	x	x	*	*	x
Cynoscion nebulosus (spotted seatrout)				x		x				x	x	x
Cynoscion regalis (weakfish)			x	*	*	x	x	x	x	x	x	
Leiostomus xanthurus (spot)			x	x	x	x	x	x	*	*		
Larimus fasciatus (banded drum)								x	x	x		
Menticirrhus americanus (s. kingfish)				x	x	x	x	x	x	x	x	x
Menticirrhus littoralis (gulf kingfish)							x			x		
Micropogonias undulatus (Atl. croaker)			x	x	x	*	x	x	*	x	x	
Pogonias cromis (black drum)												x
Sciaenops ocellata (red drum)	x											
Spadefishes												
Chaetodipterus faber (Atl. spadefish)									x	x		
Wrasses												
Tautoga onitis (tautog)			x							x	x	
Mullets												
Mugil cephalus (striped mullet)										x	x	
Barracudas												
Sphyraena borealis (n. sennet)						x	x			x		
Stargazers												
Astroscopus guttatus (n. stargazer)								x				

Table 3. Cont.

Species	Month(s) of Occurence											
	J	F	M	A	M	J	J	A	S	O	N	D
Blennies												
Chasmodes bosquianus (striped blenny)												x
Hypsoblennius hentzi (feather blenny)		x	x	x		x				x	x	x
Gobies												
Gobiosoma bosci (naked goby)	x	x	x	x	x	x		x	x	x	x	x
Gobiosoma ginsburgi (seaboard goby)	x									x	x	
Microgobius thalassinus (green goby)	x								x			
Cutlassfishes												
Trichiurus lepturus (Atl. cutlassfish)					x	x	x	x	*	x		
Mackerels												
Euthynnus alletteratus (little tunny)										x		
Sarda sarda (Atl. bonito)									x			
Scomber scombrus (Atl. mackerel)			x	x								
Scomberomorus cavalla (king mackerel)					x	*	x	x	*	x		
Scomberomorus maculatus (Spanish mackerel)			x			x	*	x	*			
Butterfishes												
Peprilus alepidotus (harvestfish)					x	x	*	*	*	x	x	
Peprilus triacanthus (butterfish)				x	x	*	*	x	*	x	x	
Searobins												
Prionctus carolinus (n. searobin)				x	x	x	x	*	x	x	x	x
Prionotus evolans (striped searobin)				*	x	x	x	x	x	*	x	x
Lefteye Flounders												
Etropus crossotus (fringed flounder)	x									x		
Etropus microstomus (smallmouth flounder)	x	*	x	x	x	x	x	x	x	*	x	x
Paralichthys dentatus (summer flounder)	x	x	x	x	x	x	x	x	*	*	*	*
Scophthalmus aquosus (windowpane)	x	*	x	x	x	x	x	x	*	x	x	x
Righteye Flounders												
Pseudopleuronectes americanus (wint. flounder)				x								
Soles												
Trinectes maculatus (hogchoker)	x	x	x	*	*	*	*	*	*	x	x	x
Tonguefishes												
Symphurus plagiusa (blackcheek toungefish)	x	x	x	x	x	x	x	x	x	x	*	x
Filefishes and Triggerfishes												
Alutera schoepfi (orange filefish)							x	x				
Balistes capriscus (gray triggerfish)							x			x		
Monacanthus hispidus (planehead filefish)								x				

Table 3. Cont.

Species	Month(s) of Occurence											
	J	F	M	A	M	J	J	A	S	O	N	D
Puffers												
Sphoeroides maculatus (n. puffer)				x	x	x	x	x	x	x		
Porcupinefishes												
Chilomycterus schoepfi (striped burrfish)					x	x	x	x	x	x		
Squids												
Lolliguncula brevis (brief squid)					x	x	x	x	*	*	x	x
Sea turtles												
Caretta caretta (loggerhead turtle)						x				x		

Table 4. Station(s) of occurrence and total number taken by gear type (x = less than 100 taken; * = more than 100 taken.

Species	Station(s) of Greatest Abundance										Total Number Taken		
	1	2	3	4	5	6	7	8	P	G	Trawls	Gill Nets	Pound Nets
Lampreys													
Petromyzon marinus (sea lamprey)									x				NC
Requieum Sharks													
Carcharhinus obscurus (dusky shark)										x		5	
Carcharhinus plumbeus (sandbar shark)										x		15	
Mustelus canis (smooth dogfish)	x								*		10		262
Dogfish Sharks													
Squalus acanthias (spiny dogfish)		x							x		1		3
Skates													
Raja eglanteria (clearnose skate)	*	x	x	x					*	x	281	16	127
Raja erinacea (little skate)									x				1
Stingrays													
Dasyatis americana (s. stingray)									x	x		2	2
Dasyatis centroura (roughtail stingray)									x				1
Dasyatis sabina (Atl. stingray)									x				4
Dasyatis sayi (bluntnose stingray)											6	2	183
Gymnura micrura (smooth butterfly ray)		x							*	x			3
Eagle Rays													
Myliobatis freminvillei (bullnose ray)		x							*	x	2	5	141
Rhinoptera bonasus (cownose ray)									*				246
Sturgeons													
Acipenser oxyrhynchus (Atl. sturgeon)										x		3	
Tarpons													
Elops saurus (ladyfish)									x				47
Megalops atlanticus (tarpon)									x				1
Eels													
Anguilla rostrata (American eel)	x	x	x		x	x	x	x			75		
Conger oceanicus (Conger eel)		x									1		
Myrophis punctatus (speckled worm eel)		x									1		

Table 4. Cont.

Species	Station(s) of Greatest Abundance										Total Number Taken		
	1	2	3	4	5	6	7	8	P	G	Trawls	Gill Nets	Pound Nets
Herrings													
Alosa aestivalis (blueback herring)	x	x	x	x	x	*	x	x	*	x	326	19	TNTC
Alosa mediocris (hickory shad)								x	x		29		17
Alosa pseudoharengus (alewife)	x	x	x	x		x		x	*		61		TNTC
Alosa sapidissima (American shad)	x				x	x	x	x	x	x	26	16	81
Brevoortia tyrannus (Atl. menhaden)	x	x	x	x	*	x	x	*	*	*	842	439	TNTC
Dorosoma cepedianum (gizzard shad)				x	x	x	x	x	x	x	111		38
Opisthonema oglinum (Atl. thread herring)				x					*		1		TNTC
Anchovies													
Anchoa mitchilli (bay anchovy)	*	*	*	*	*	*	*	*		x	46,582		20
Lizardfishes													
Synodus foetens (inshore lizardfish)	x	x	x	x	x				x	x	17	1	34
Carps and Minnows													
Cyprinus carpio (common carp)									x				NC
Toadfishes													
Opsanus tau (oyster toadfish)	x	x	x	x	x	x	x	x	x	x	126	10	6
Clingfishes													
Gobiesox strumosus (skillet fish)	x	x		x	x	x	x	x			13		
Goosefishes													
Lophius americanus (goosefish)									x				NC
Codfishes													
Gadus morhua (Atl. cod)			x								1		
Merluccius bilinearis (silver hake)	x	x	x	x					x		120		1
Urophycis chuss (red hake)	*	x	x	x	x	x	x	x	x		769		53
Urophycis regia (spotted hake)	*	*	*	x	*	*	*	*	x	x	3,080	5	92
Cusk-eels													
Ophidion marginatum (striped cusk-eel)	x	x	x	x	x	x	x	x			125		
Killifishes													
Fundulus majalis (striped killifish)							x				1		

TABLE 4. CONT.

Species	Station(s) of Greatest Abundance										Total Number Taken		
	1	2	3	4	5	6	7	8	P	G	Trawls	Gill Nets	Pound Nets
Silversides													
Menidia menidia (Atl. silverside)	x	x	x	x	x	*	x	x	x		416		2
Pipefishes and Seahorses													
Hippocampus erectus (lined seahorse)	x	x	x	x							10		
Syngnathus floridae (dusky pipefish)							x	x			2		
Syngnathus fuscus (northern pipefish)	x	x	x	x	x		x	x			79		
Syngnathus louisianae (chain pipefish)			x								1		
Temperate Basses													
Morone americana (white perch)				x				x	x	x	44	2	79
Morone saxatilis (striped bass)						x		x			5		
Sea Basses													
Centropristis striata (black sea bass)	x	x	x	x	x		x		x	x	64	3	1
Mycteroperca microlepis (gag)		x							x		1		3
Bluefishes													
Pomatomus saltatrix (bluefish)	x		x		x	x		x	*	*	44	296	TNTC
Cobias													
Rachycentron canadum (cobia)									x				1
Remoras													
Echeneis naucrates (sharksucker)									x				4
Jacks													
Caranx chrysos (blue runner)									x				99
Caranx hippos (crevalle jack)		x				x			*	x	2	2	451
Oligoplites saurus (leatherjacket)									x				2
Selene vomer (lookdown)									x				55
Selene setapinnis (Atl. moonfish)				x			x		x		2		56
Seriola dumerili (greater amberjack)									x				7
Seriola zonata (banded rudderfish)									x				6
Trachinotus carolinus (Florida pompano)									x				79
Grunts													
Orthopristis chrysoptera (pigfish)			x						x	x	2	1	79

Table 4. Cont.

Species	Station(s) of Greatest Abundance										Total Number Taken		
	1	2	3	4	5	6	7	8	P	G	Trawls	Gill Nets	Pound Nets
Porgies													
Archosargus probatocephalus (sheepshead)									x				NC
Stenotomus chrysops (scup)	*	*	x				x		x	x	375	5	59
Drums													
Bairdiella chrysoura (silver perch)	x	x	x	x	x	x	x	x	*		88		TNTC
Cynoscion nebulosus (spotted seatrout)			x						x		1		18
Cynoscion regalis (weakfish)	*	*	*	*	*	*	*	*	*	*	2,845	142	TNTC
Leiostomus xanthurus (spot)	*	*	*	*	*	*	*	*	*	*	22,907	512	TNTC
Larimus fasciatus (banded drum)	x	x				x			x		6		1
Menticirrhus americanus (s. kingfish)	x	x	x	x					x	x	31	3	32
Menticirrhus littoralis (gulf kingfish)	x								x		3		5
Micropogonias undulatus (Atl. croaker)	*	*	*	*	*	*	*	*	*	*	5661	142	TNTC
Pogonias cromis (black drum)			x								1		
Sciaenops ocellata (red drum)			x			x			x		2		1
Spadefishes													
Chaetodipterus faber (Atl. spadefish)					x	x			x		2		9
Wrasses													
Tautoga onitis (tautog)			x							x	1	3	
Mullets													
Mugil cephalus (striped mullet)									*		5		TNTC
Barracudas													
Sphyraena borealis (n. sennet)		x							x		1		2
Stargazers													
Astroscopus guttatus (n. stargazer)						x			x	x	1	1	3
Blennies													
Chasmodes bosquianus (striped blenny)					x						1		
Hypsoblennius hentzi (feather blenny)	x	x	x	x	x						18		
Gobies													
Gobiosoma bosci (naked goby)	x		x	x	x	x	x	x			80		
Gobiosoma ginsburgi (seaboard goby)	x			x		x					12		
Microgobius thalassinus (green goby)						x					4		

Species	Station(s) of Greatest Abundance										Total Number Taken		
	1	2	3	4	5	6	7	8	P	G	Trawls	Gill Nets	Pound Nets
Cutlassfishes													
Trichiurus lepturus (Atl. cutlassfish)						x			*		1		1294
Mackerels													
Euthynnus alletteratus (little tunny)									x				1
Sarda sarda (Atl. bonito)									x				15
Scomber scombrus (Atl. mackerel)									x				NC
Scomberomorus cavalla (king mackerel)									x				30
Scomberomorus maculatus (Spanish mackerel)									*				367
Butterfishes													
Peprilus alepidotus (harvestfish)			x	x	x	x	x	x	*	x	31	1	TNTC
Peprilus triacanthus (butterfish)	x	x	x	x	x		x	x	*	x	86	20	TNTC
Searobins													
Prionotus carolinus (n. searobin)	x	x	x	x	x	x		x	x	x	174	1	3
Prionotus evolans (striped searobin)	x	x	x	x		x	x	x	x	x	27	10	81
Lefteye Flounders													
Etropus crossotus (fringed flounder)		x		x							2		
Etropus microstomus (smallmouth flounder)	*	*	x	x	x	x	x				327		
Paralichthys dentatus (summer flounder)	*	*	*	*	x	x	x	*	*	x	957	81	TNTC
Scophthalmus aquosus (windowpane)	x	x	x	x	x	x		x	x		202		105
Righteye Flounders													
Pseudopleuronectes americanus (wint. flounder)		x								x	1	2	
Soles													
Trinectes maculatus (hogchoker)	x	x	x	*	x	*	*	*	x	x	4,395	43	57
Tonguefishes													
Symphurus plagiusa (blackcheek toungefish)	x	x	x	x	x	x	x	x	x		104		4
Filefishes and Triggerfishes													
Alutera schoepfi (orange filefish)									x				3
Balistes capriscus (gray triggerfish)									x				2
Monacanthus hispidus (planehead filefish)									x				1

Table 4. Cont.

Species	Station(s) of Greatest Abundance										Total Number Taken		
	1	2	3	4	5	6	7	8	P	G	Trawls	Gill Nets	Pound Nets
Puffers Sphoeroides maculatus (n. puffer)	x		x	x			x		x		19		38
Porcupinefishes Chilomycterus schoepfi (striped burrfish)									x				47
Squids Lolliguncula brevis (brief squid)	*	*	*	x	x	x			x		639		27
Sea turtles Caretta caretta (loggerhead turtle)									x				3

Table 5. Summation of trawl catch at station 1 in 1982 - 83 for the 18 most abundant species.

Species	Number Caught	Rank Among Stations
Fishes		
Anchoa mitchilli	2,810	5
Urophycis chuss	609	1
Cynoscion regalis	368	5
Leiostomus xanthurus	368	8
Raja eglanteria	228	1
Stenotomus chrysops	208	1
Urophycis regia	178	5
Etropus microstomus	139	2
Paralichthys dentatus	131	4
Micropogonias undulatus	112	8
Prionotus carolinus	78	1
Merluccius bilinearis	64	1
Ophidion marginatum	60	1
Scophthalmus aquosus	49	2
Peprilus triacanthus	28	1
Centropristis striata	22	1
Sphoeroides maculatus	15	1
Squids		
Lolliguncula brevis	295	1
Total Species Caught	41	3
Total Specimens caught	5,574	7

Table 6. Summation of trawl catch at station 2 in 1982 - 1983 for the 20 most abundant species.

Species	Number Caught	Rank Among Stations
Fishes		
Anchoa mitchilli	1,121	8
Leiostomus xanthurus	1,013	7
Micropogonias undulatus	621	3
Cynoscion regalis	585	4
Paralichthys dentatus	165	2
Etropus microstomus	165	1
Urophycis regia	142	6
Stenotomus chrysops	142	2
Urophycis chuss	78	2
Scopthalmus aquosus	72	1
Trinectes maculatus	66	6
Merluccius bilinearis	52	2
Raja eglanteria	49	2
Prionotus carolinus	45	2
Syngnathus fuscus	37	1
Menidia menidia	30	6
Peprilus triacanthus	28	1
Symphurus plagiusa	27	2
Alosa pseudoharengus	25	1
Squids		
Lolliguncula brevis	124	2
Total Species Caught	43	2
Total Specimens Caught	4,539	8

Table 7. Summation of trawl catch at station 3 in 1982 - 83 for the 15 most abundant species.

Species	Number Caugnt	Rank Among Stations
Fishes		
Leiostomus xanthurus	5,926	1
Anchoa mitchilli	1,449	6
Micropogonias undulatus	208	6
Cynoscion regalis	164	8
Paralichthys dentatus	123	5
Urophycis regia	112	7
Brevoortia tyrannus	95	3
Menidia menidia	72	2
Scophthalmus aquosus	37	4
Pomatomus saltatrix	36	1
Trinectes maculatus	27	7
Prionotus carolinus	26	3
Opsanus tau	19	4
Alosa pseudoharengus	18	2
Squids		
Lolliguncula brevis	110	3
Total Species Caught	44	1
Total Specimens Caught	8,464	5

Table 8. Summation of trawl catch at station 4 in 1982 - 83 for the 14 most abundant species.

Species	Number Caught	Rank Among Stations
Fishes		
Anchoa mitchilli	9,060	3
Leiostomus xanthurus	3,163	3
Cynoscion regalis	677	2
Micropogonias undulatus	305	5
Paralichthys dentatus	212	1
Trinectes maculatus	114	4
Brevoortia tyrannus	90	4
Urophycis regia	86	8
Menidia menidia	48	3
Scophthalmus aquosus	40	3
Symphurus plagiusa	38	1
Opsanus tau	24	2
Centropristis striata	12	3
Squids		
Lolliguncula brevis	48	5
Total Species Caught	40	4
Total Specimens Caught	14,054	2

Table 9. Summation of trawl catch at station 5 in 1982 - 83 for the 13 most abundant species.

Species	Number Caught	Rank Among Stations
Fishes		
Anchoa mitchilli	9,750	2
Leiostomus xanthurus	2,261	5
Cynoscion regalis	338	6
Brevoortia tyrannus	213	2
Urophycis regia	206	4
Micropogonias undulatus	174	7
Trinectes maculatus	96	5
Paralichthys dentatus	95	6
Alosa aestivalis	50	3
Menidia menidia	28	7
Urophycis chuss	27	3
Opsanus tau	19	4
Squids		
Lolliguncula brevis	58	4
Total Species Caught	33	6
Total Specimens Caught	13,309	3

Table 10. Summation of trawl catch at station 6 in 1982-83 for the 14 most abundant species.

Species	Number Caught	Rank Among Stations
Fishes		
Anchoa mitchilli	14,104	1
Leiostomus xanthurus	5,665	2
Micropogonias undulatus	1,914	1
Urophycis regia	1,228	1
Trinectes maculatus	1,142	2
Cynoscion regalis	734	1
Alosa aestivalis	152	1
Menidia menidia	149	1
Paralichthys dentatus	80	7
Brevoortia tyrannus	56	6
Bairdiella chrysoura	36	1
Opsanus tau	23	3
Gobiosoma bosci	23	2
Urophycis chuss	21	4
Total Species Caught	37	5
Total Specimens Caught	25,401	1

Table 11. Summation of trawl catch at station 7 in 1982-83 for the 13 most abundant species.

Species	Number Caught	Rank Among Stations
Fishes		
Leiostomus xanthurus	3,090	4
Micropogonias undulatus	1,816	2
Anchoa mitchilli	1,365	7
Cynoscion regalis	654	3
Trinectes maculatus	526	3
Urophycis regia	427	3
Brevoortia tyrannus	62	5
Menidia menidia	41	5
Alosa aestivalis	37	4
Gobiosoma bosci	35	1
Opsanus tau	32	1
Ophidion marginatum	23	3
Paralichthys dentatus	20	8
Total Species Caught	31	8
Total Specimens Caught	8,200	6

Table 12. Summation of trawl catch at station 8 in 1982-83 for the 13 most abundant species.

Species	Number Caught	Rank Among Stations
Fishes		
Anchoa mitchilli	6,926	4
Trinectes maculatus	2,413	1
Leiostomus xanthurus	1,416	6
Urophycis regia	696	2
Micropogonias undulatus	509	4
Cynoscion regalis	325	7
Brevoortia tyrannus	310	1
Paralichthys dentatus	158	3
Alosa aestivalis	64	2
Morone americana	43	1
Menidia menidia	35	4
Ophidion marginatum	31	2
Alosa mediocris	29	1
Total Species Caught	32	7
Total Specimens Caught	13,185	4

Table 13. Sediment concentration of polynuclear aromatic hydrocarbons in the Elizabeth River.*

PNA	Site (ng/g dry wt.)		
	G	L	M
Napthalene		167	120
Acenaphthylene		71	120
Acenaphthene	68	98	248
Fluorene	46	209	406
Phenanthrene	233	781	1469
Anthracene	64	165	441
Flouranthene	196	1188	1717
Pyrene	308	1171	1499
Benzo(a)anthracene	225	501	428
Chrysene	156	1143	974
Dibenzo(a,h)anthracene		140	
1,12 Benzo perylene		200	
Benzo(a)pyrene		657	435
Benzo(b)fluoranthene			5337
Benzo(k)fluoranthene		5189	

*These data have been provided from the unpublished work of R. W. Alden, III, Applied Marine Research Laboratory, Old Dominion Univerity.

Table 14. Comparison of the Southern Branch and the Western Branch of the Elizabeth River in frequency of diseased and anomalous fishes from June 1983 - August 1984.

Locale	Fishes Examined	Number Diseased or Anomalous	Percent diseased or Anomalous
Southern Branch	4,298	194	4.5
Western Branch	2,966	2	0.07

Table 15. Types of anomilies observed by species of fish in the Southern Branch of the Elizabeth River, June - August, 1984.

Species	Eroded Fins	Bloody Fins	Body Lesions	Cataracts
American eel	-	1	-	-
spotted hake	-	22	4	25
oyster toadfish	5	11	-	-
spot	7	-	-	22
croaker	2	-	2	5
weakfish	-	-	-	2
hogchoker	7	6	-	-
summer flounder	-	2	-	-
Total	21	42	6	54

Table 16. Commercial fish catch of the 11 most abundant species in NMFS area 311, lower Chesapeake Bay.*

Species	Pounds Landed	
	1982	1983
bluefish	1,128,190	250,127
weakfish	449,469	300,961
spot	436,258	596,640
croaker	87,552	103,118
harvestfish	34,332	39,102
summer flounder	24,481	66,346
alewife	16,774	151
butterfish	14,598	33,562
Spanish mackerel	11,486	2,329
American shad	10,157	15,066
mullets	4,390	13,143

*Industrial fish and menhaden excluded.

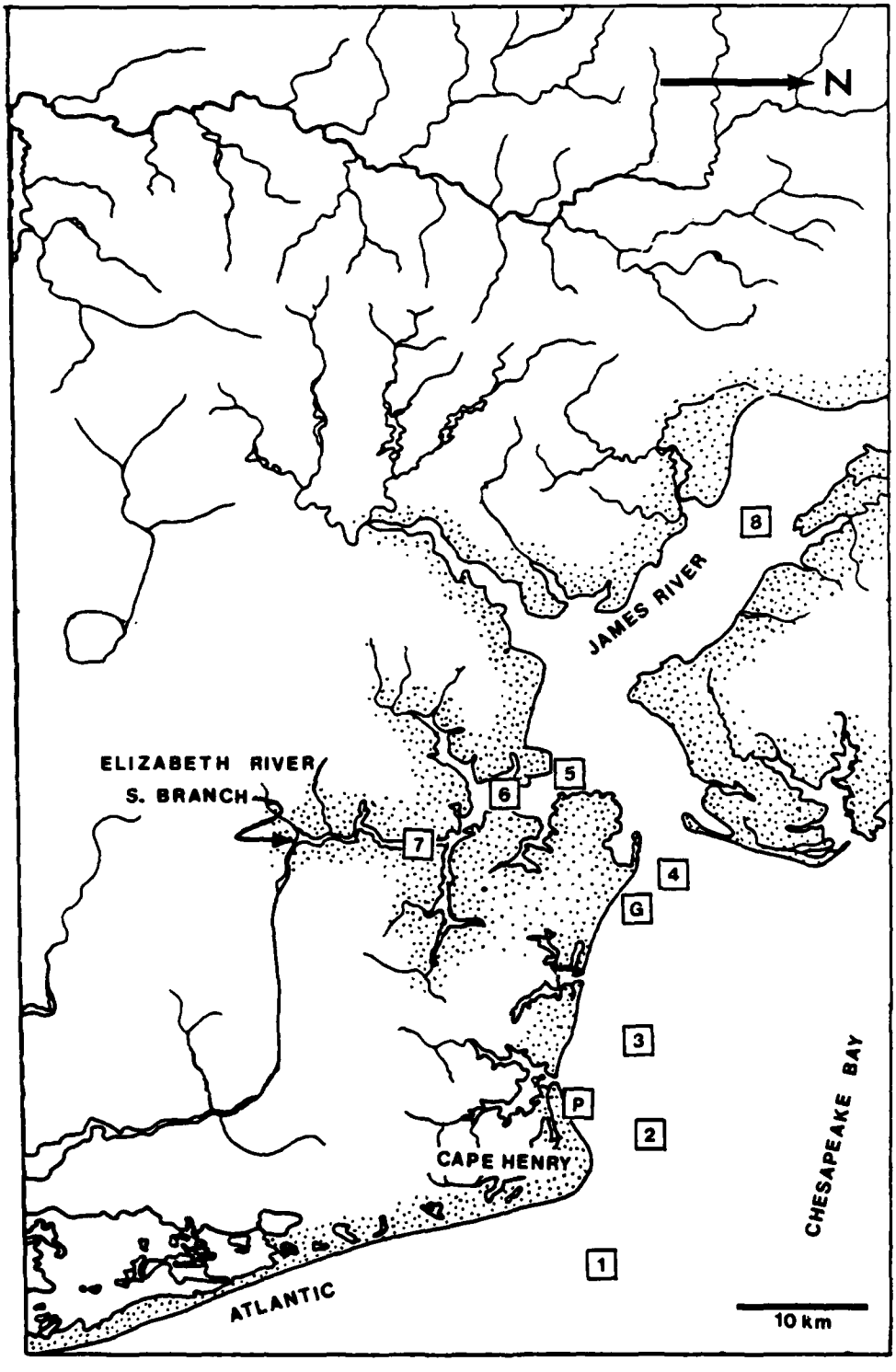

Fig. 1. Map of study area indicating the eight trawl stations (numbered squares), gillnet station (G), and poundnet station (P).

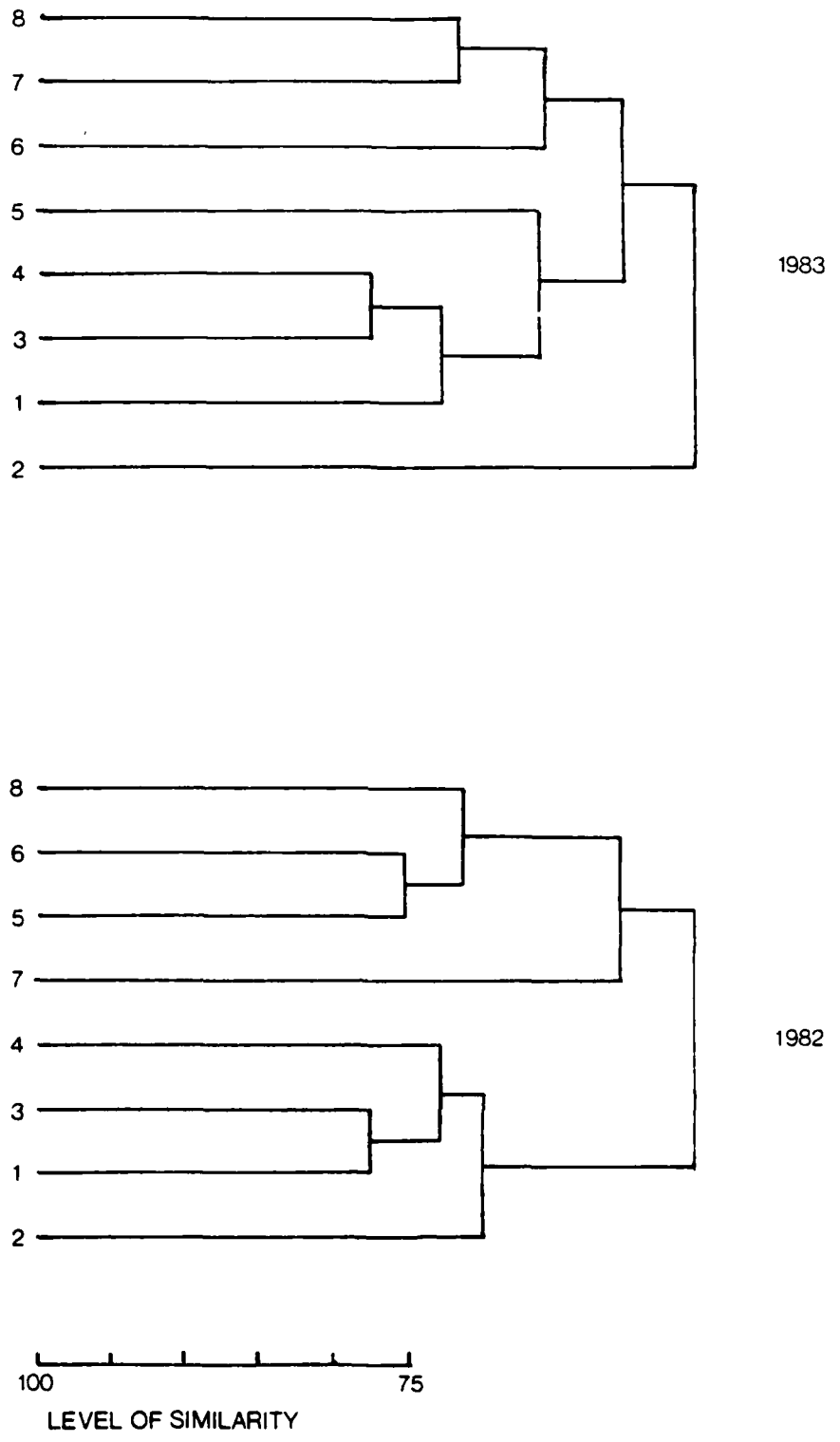

Fig. 2. Phenograms resulting from the cluster analysis for similarity between the eight trawl stations for 1982 and 1983.

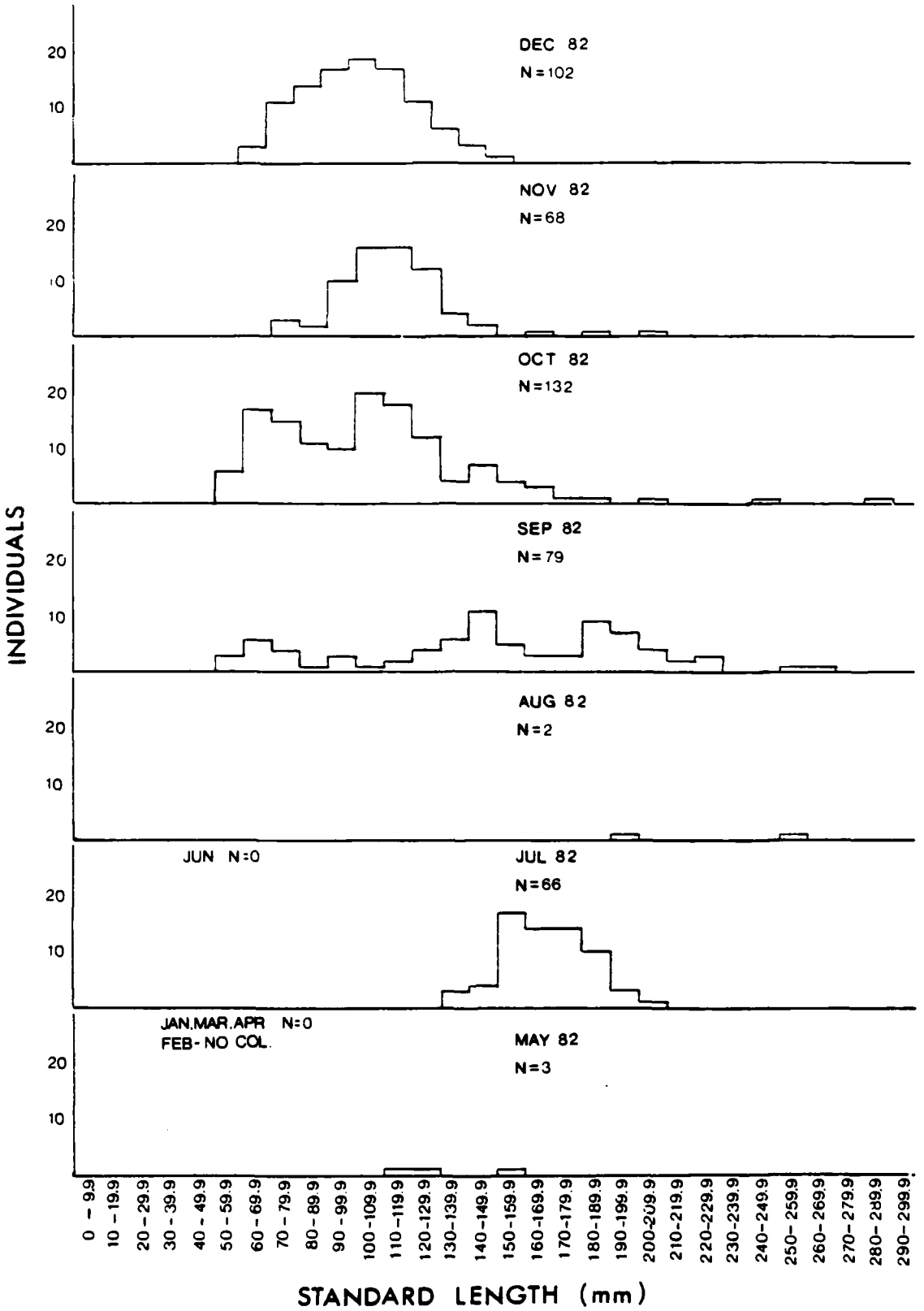

Fig. 3. Size frequency distribution of Cynoscion regalis (weakfish) at stations 1 through 4 (pooled) for May 1982 through December 1982.

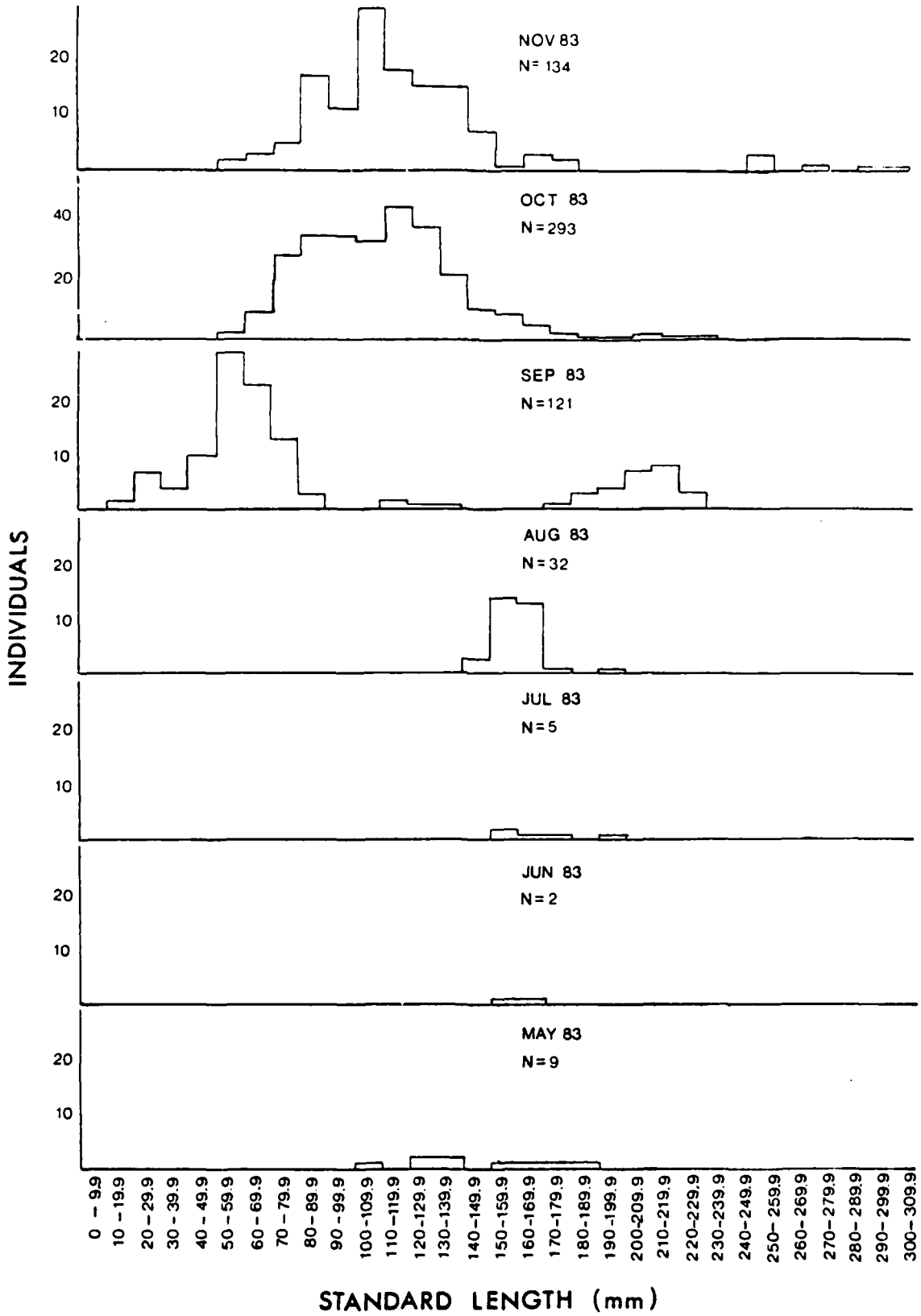

Fig. 4. Size frequency distribution of Cynoscion regalis (weakfish) at stations 1 through 4 (pooled) for May 1983 through November 1983.

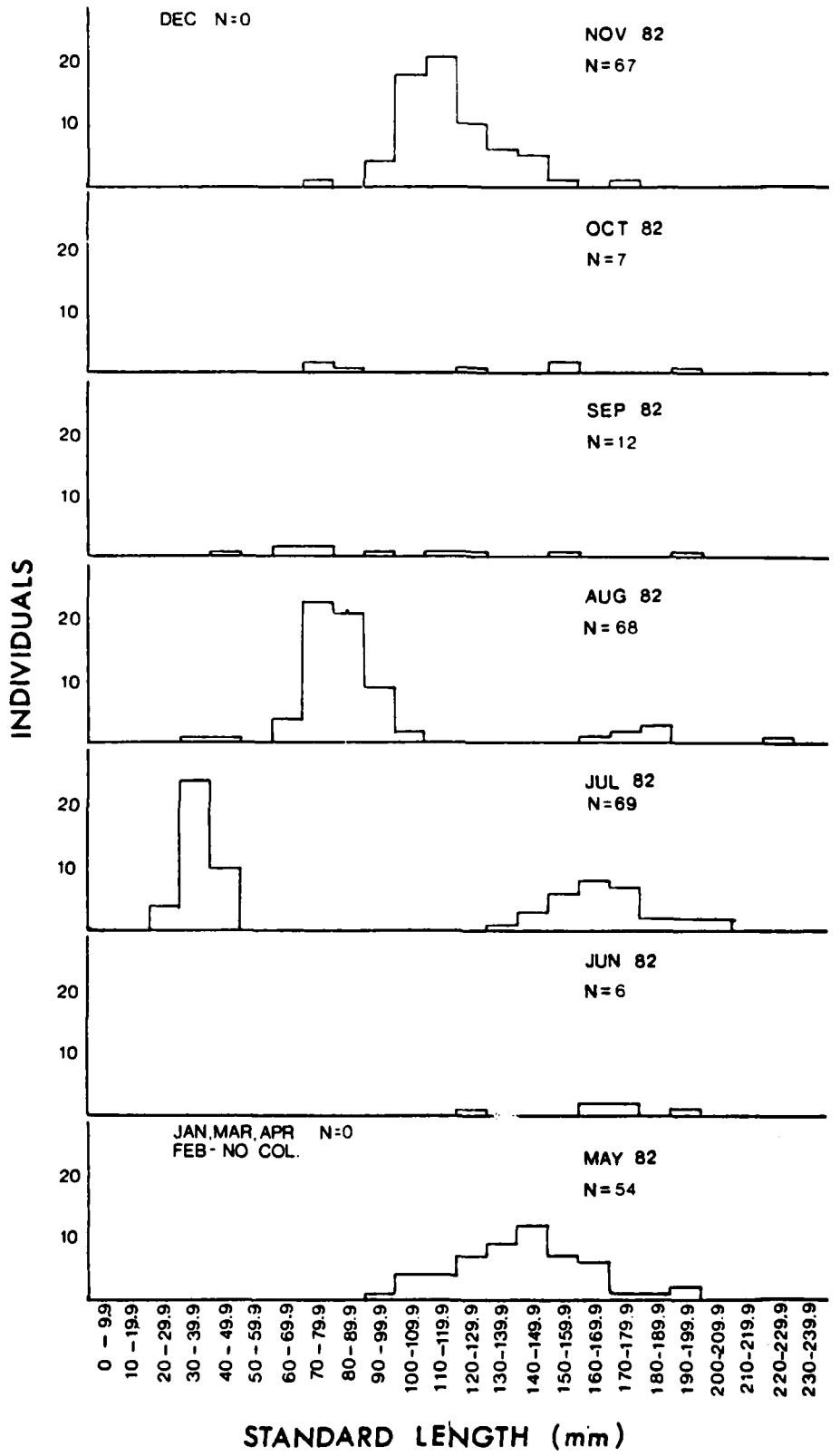

Fig. 5. Size frequency distribution of Cynoscion regalis (weakfish) at stations 5 and 6 (pooled) for May 1982 November 1982.

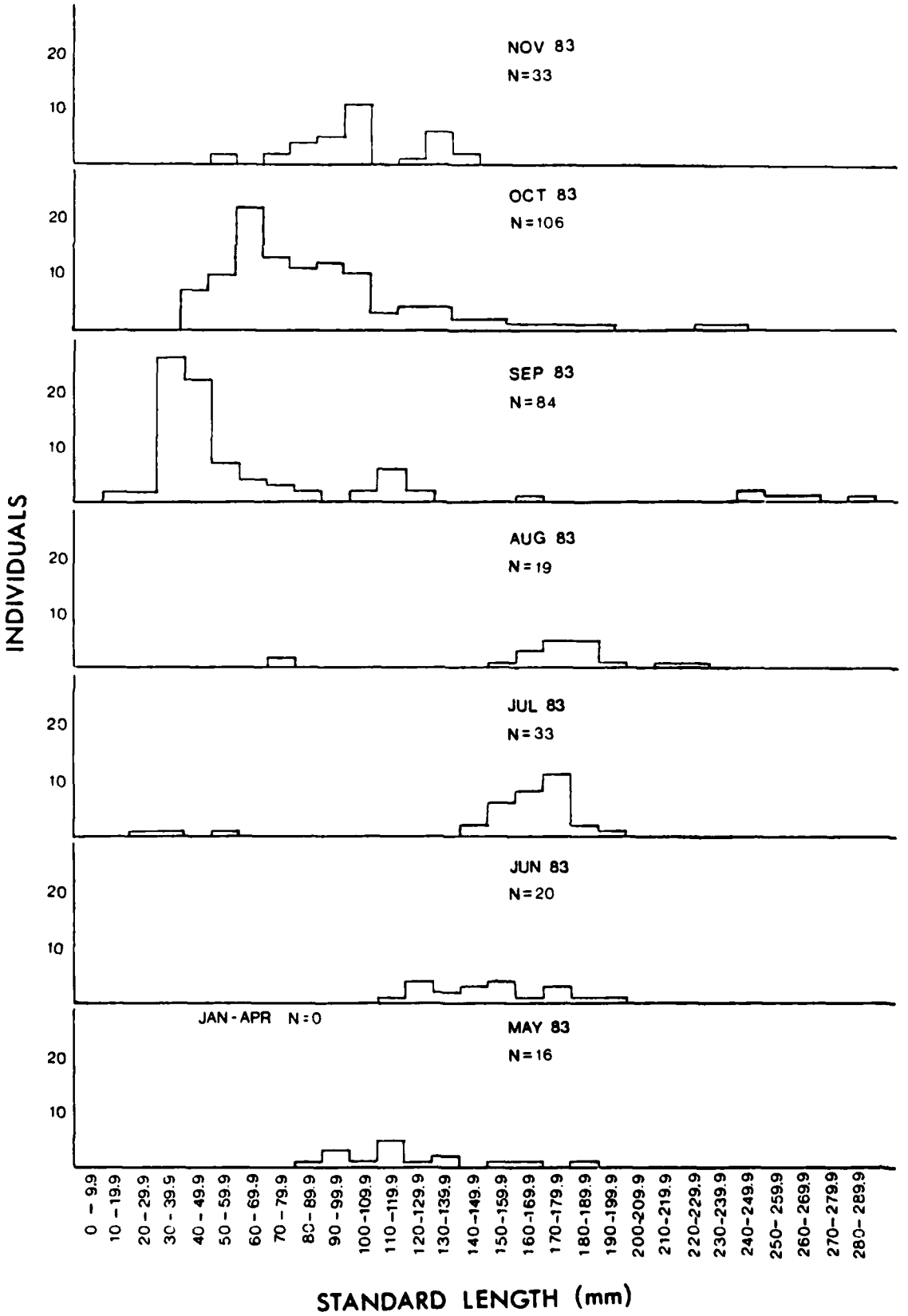

Fig. 6. Size frequency distribution of Cynoscion regalis (weakfish) at stations 5 and 6 (pooled) for May 1983 through November 1983.

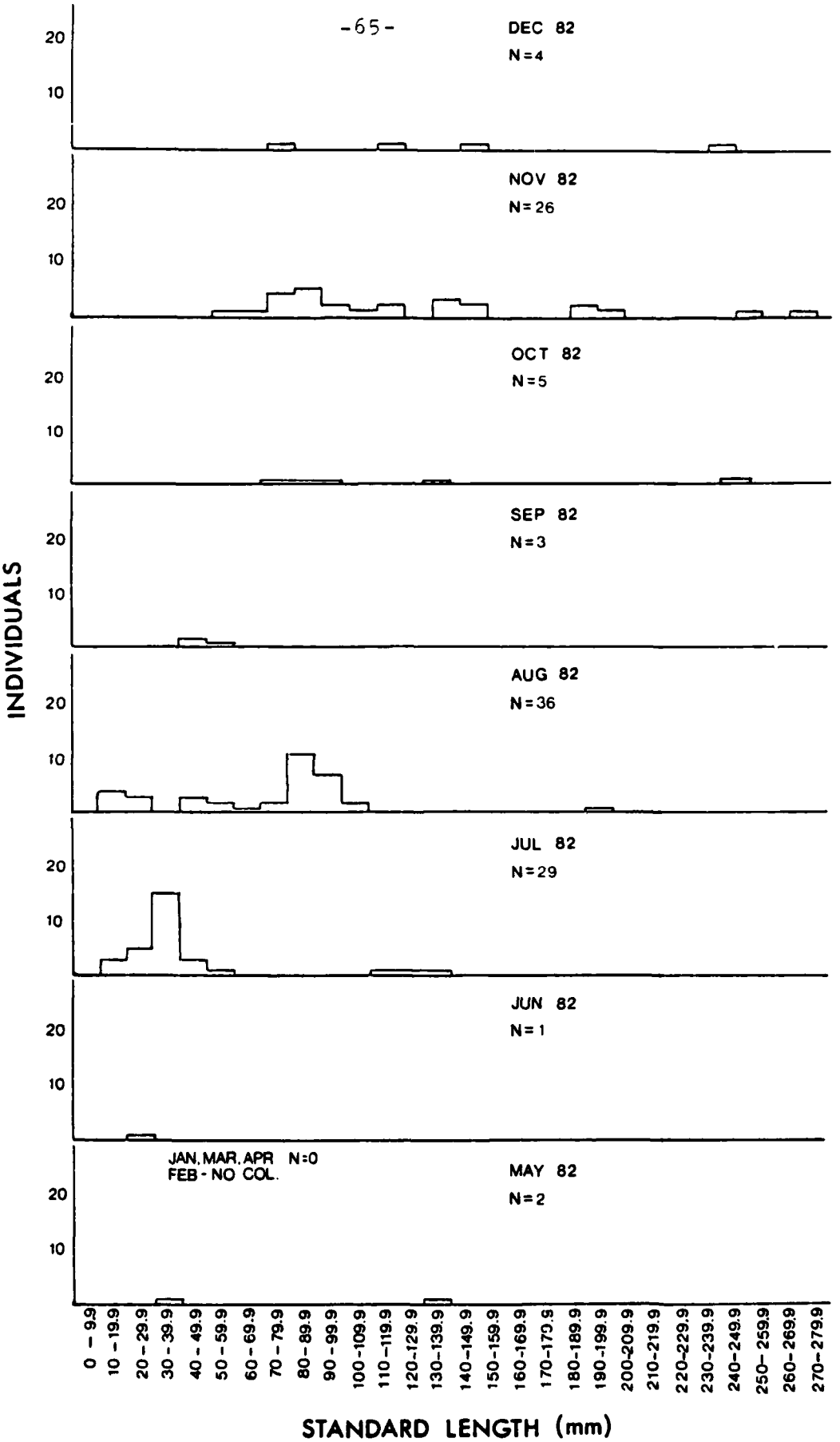

Fig. 7. Size frequency distribution of Cynoscion regalis (weakfish) at station 7 for May 1982 through December 1982.

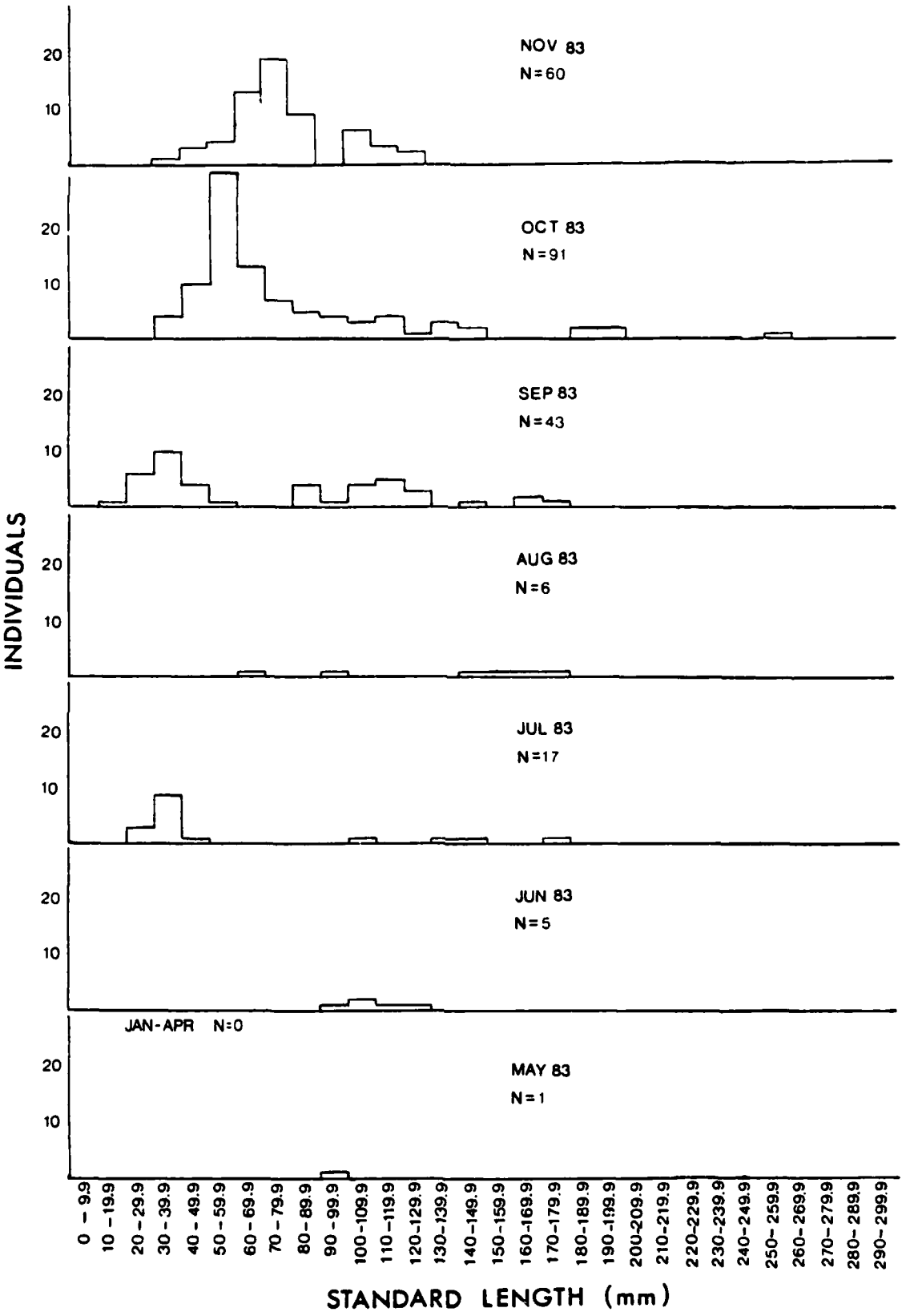

Fig. 8. Size frequency distribution of Cynoscion regalis (weakfish) at station 7 for May 1983 through November 1983.

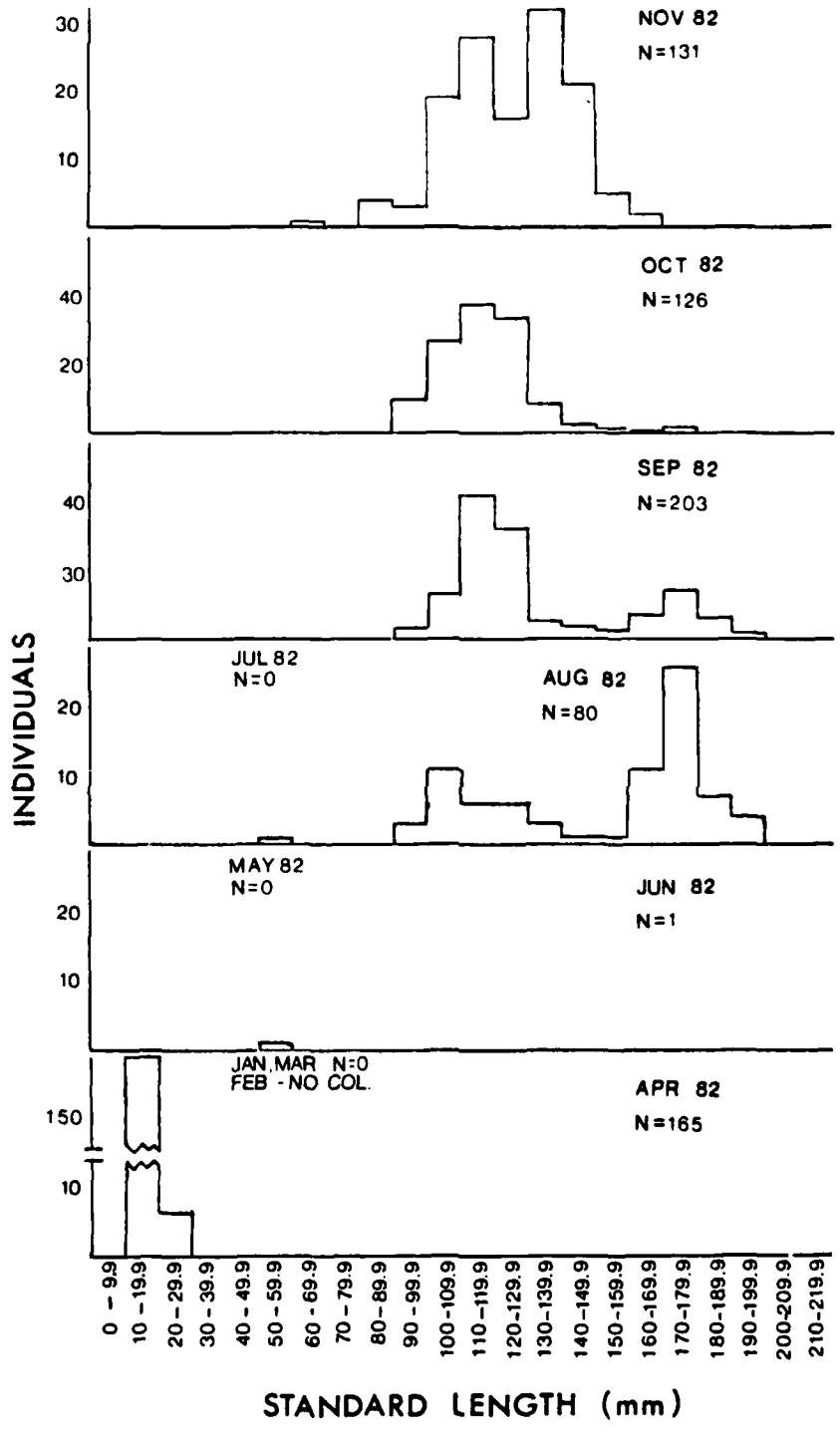

Fig. 9. Size frequency distribution of Leiostomus xanthurus (spot) at stations 1 through 4 (pooled) for April 1982 through November 1982.

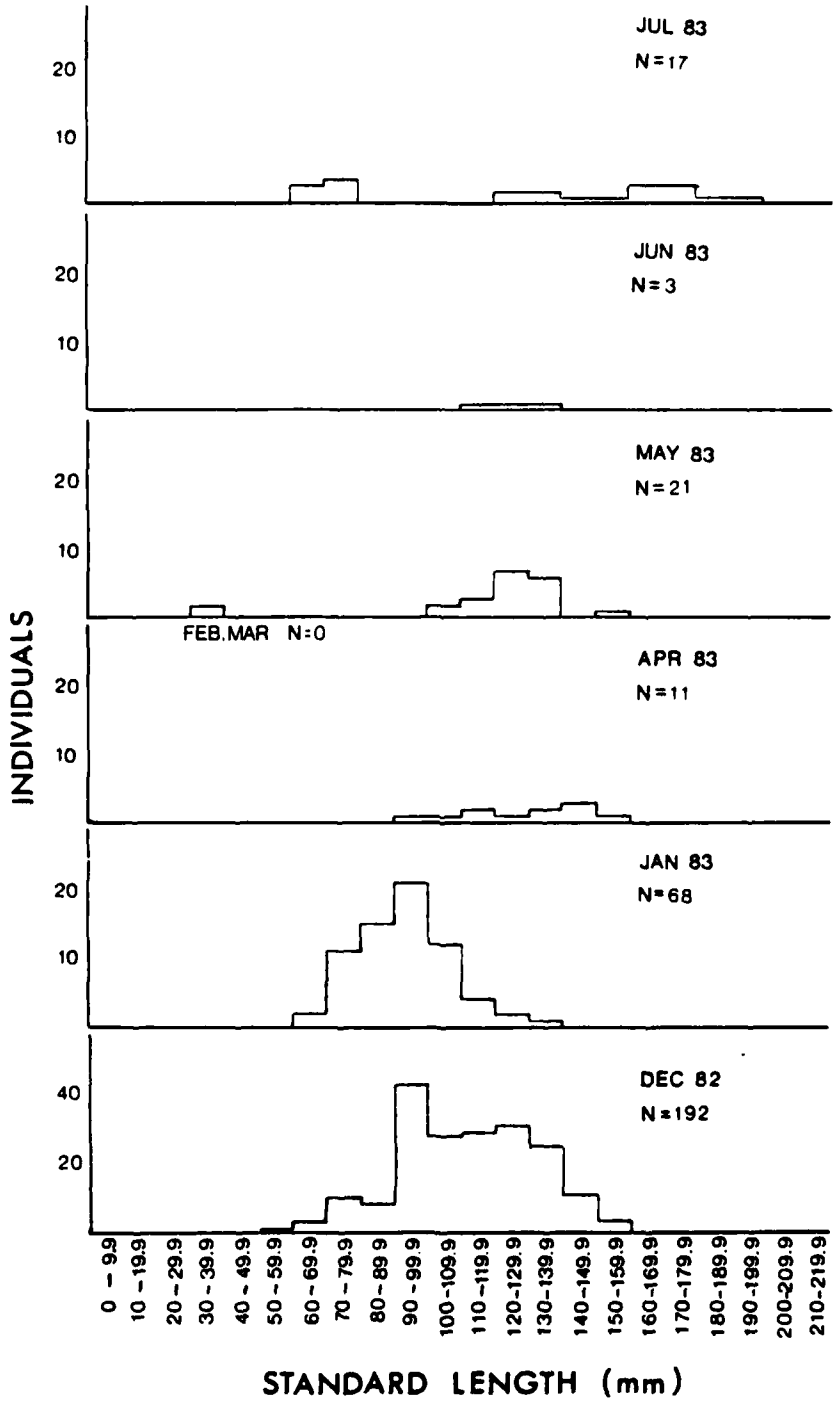

Fig. 10. Size frequency distribution of Leiostomus xanthurus (spot) at stations 1 through 4 (pooled) for December 1982 through July 1983.

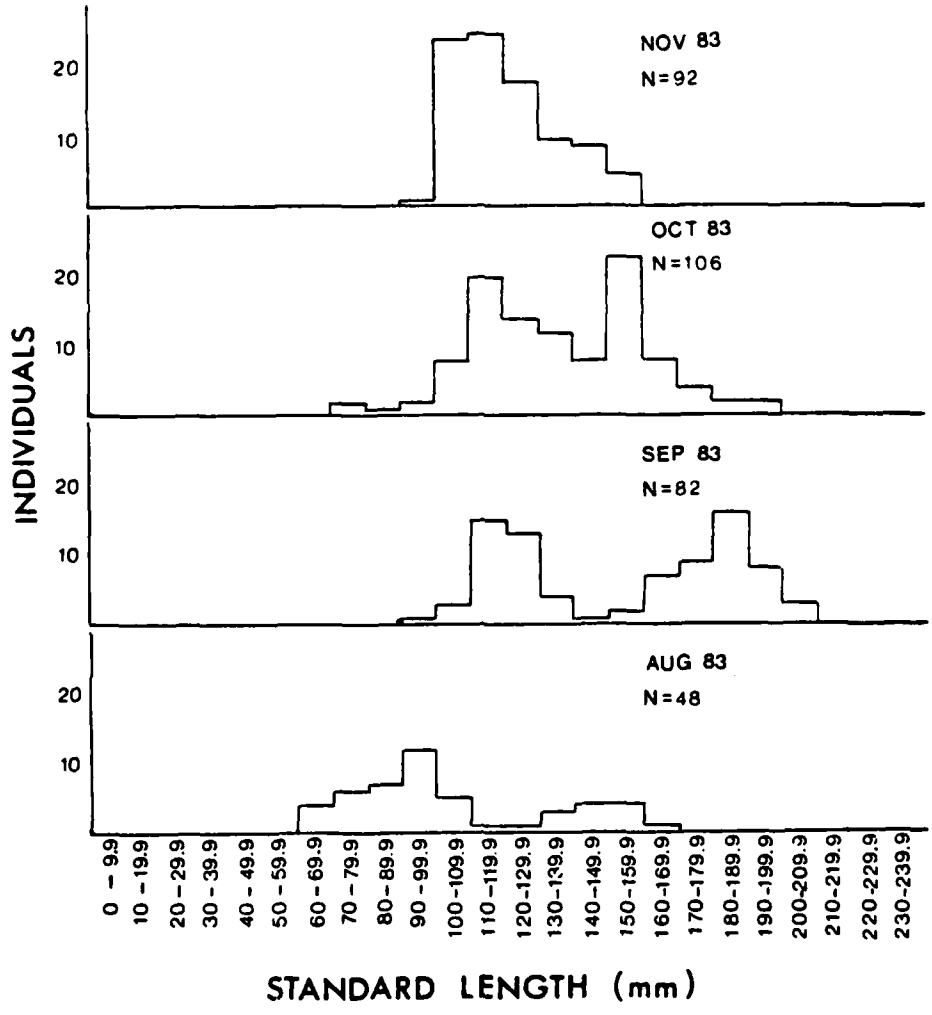

Fig. 11. Size frequency distribution of Leiostomus xanthurus (spot) at stations 1 through 4 (pooled) for August 1983 through November 1983.

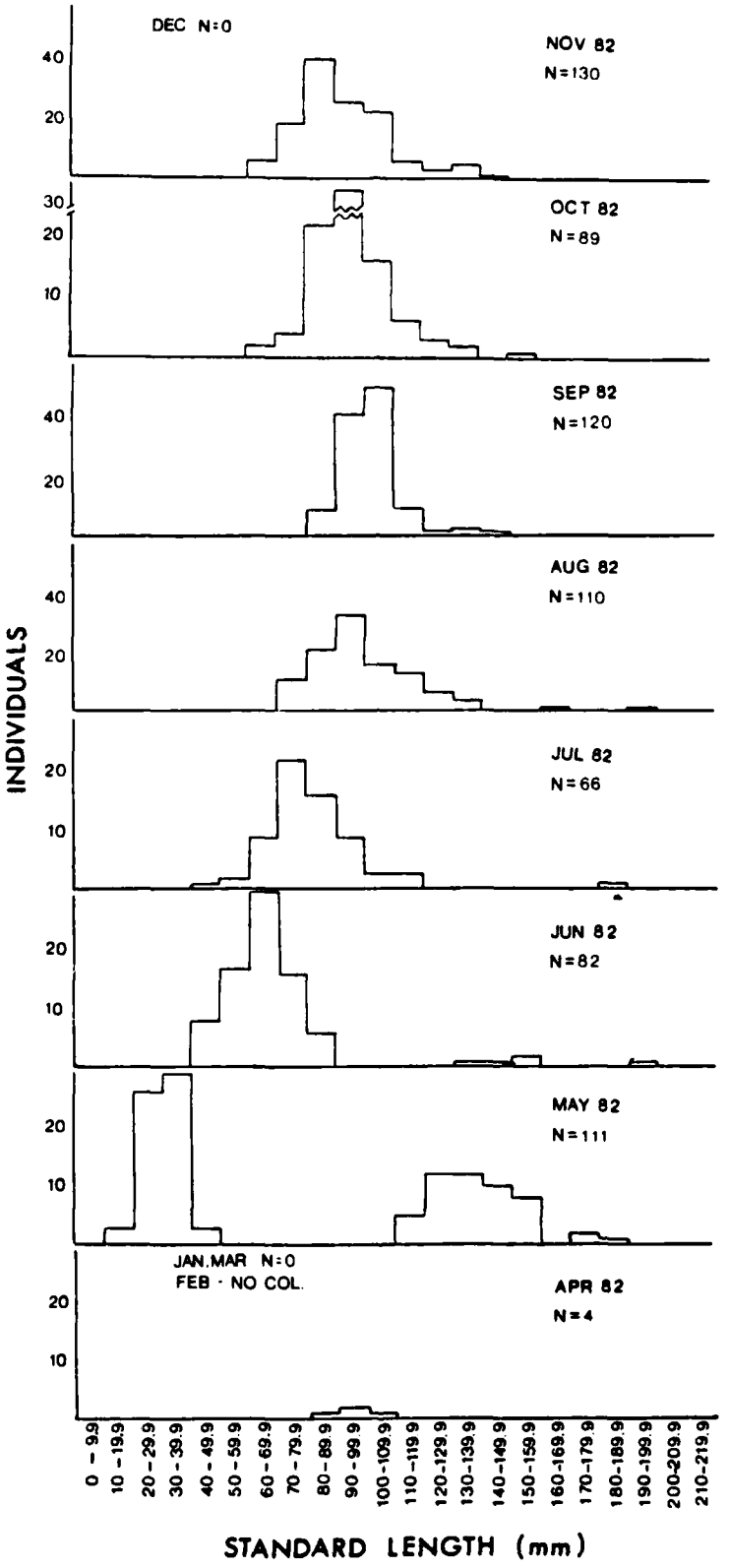

Fig. 12. Size frequency distribution of Leiostomus xanthurus (spot) at stations 5 and 6 (pooled) for April 1982 through November 1982.

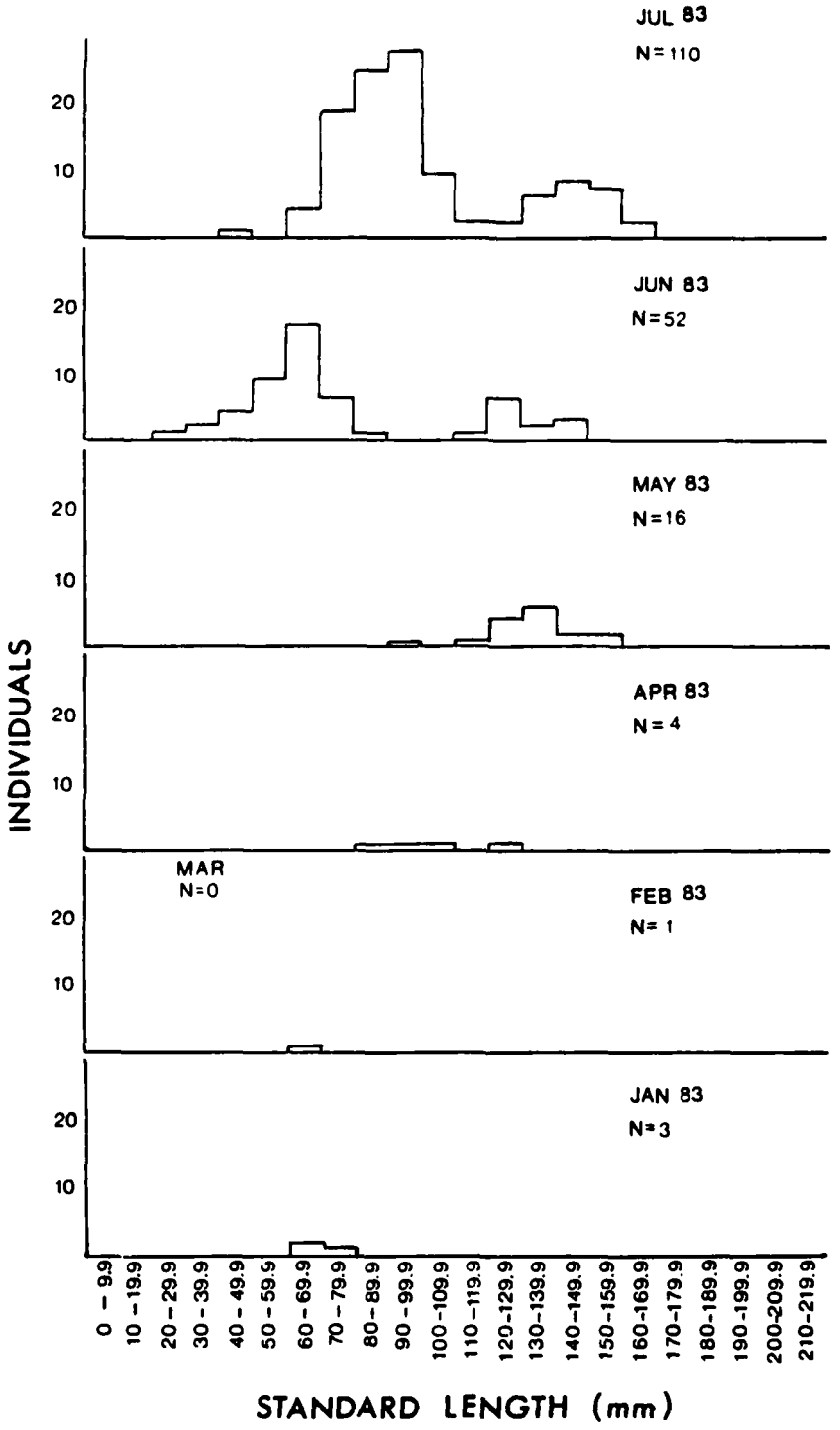

Fig. 13. Size frequency distribution of Leiostomus xanthurus (spot) at stations 5 and 6 (pooled) for January 1983 through July 1983.

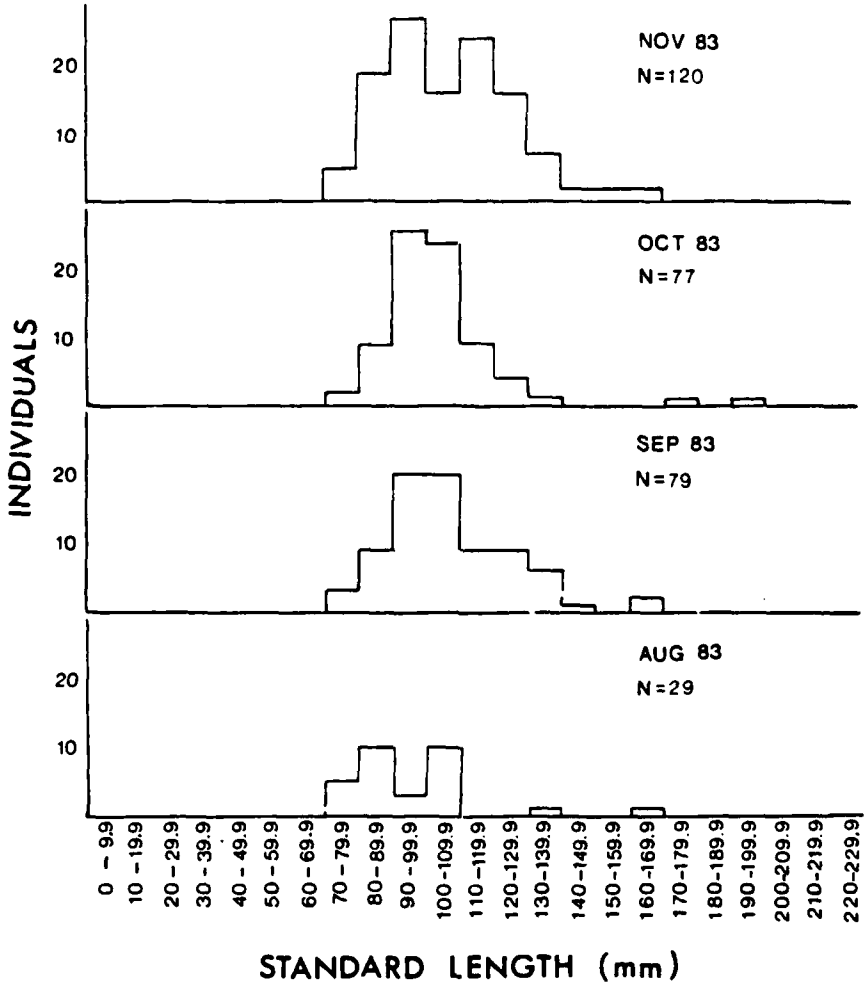

Fig. 14. Size frequency distribution of Leiostomus xanthurus (spot) at stations 5 and 6 (pooled) for August 1983 through November 1983.

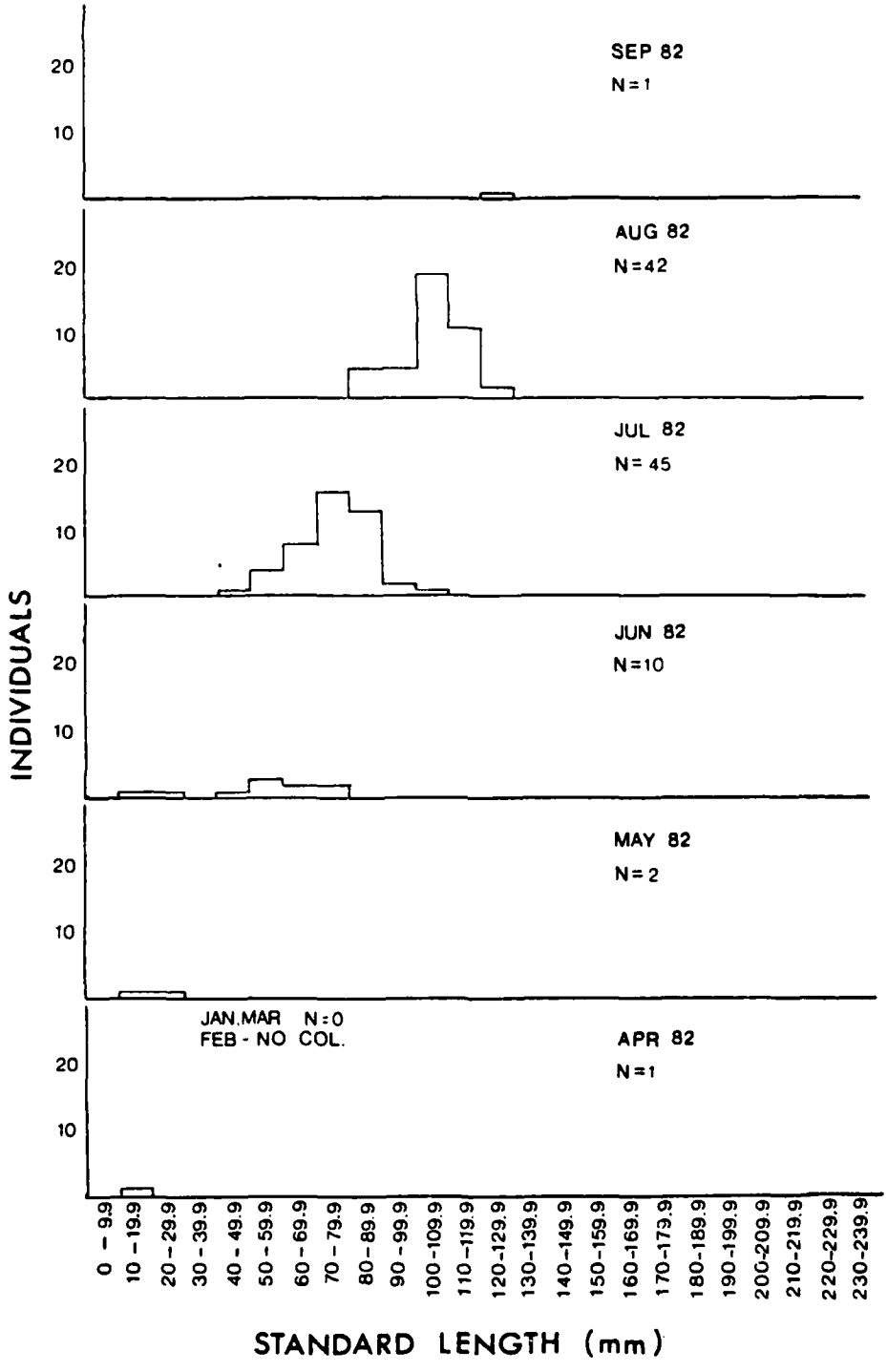

Fig. 15. Size frequency distribution of Leiostomus xanthurus (spot) at station 7 for April 1982 through September 1982.

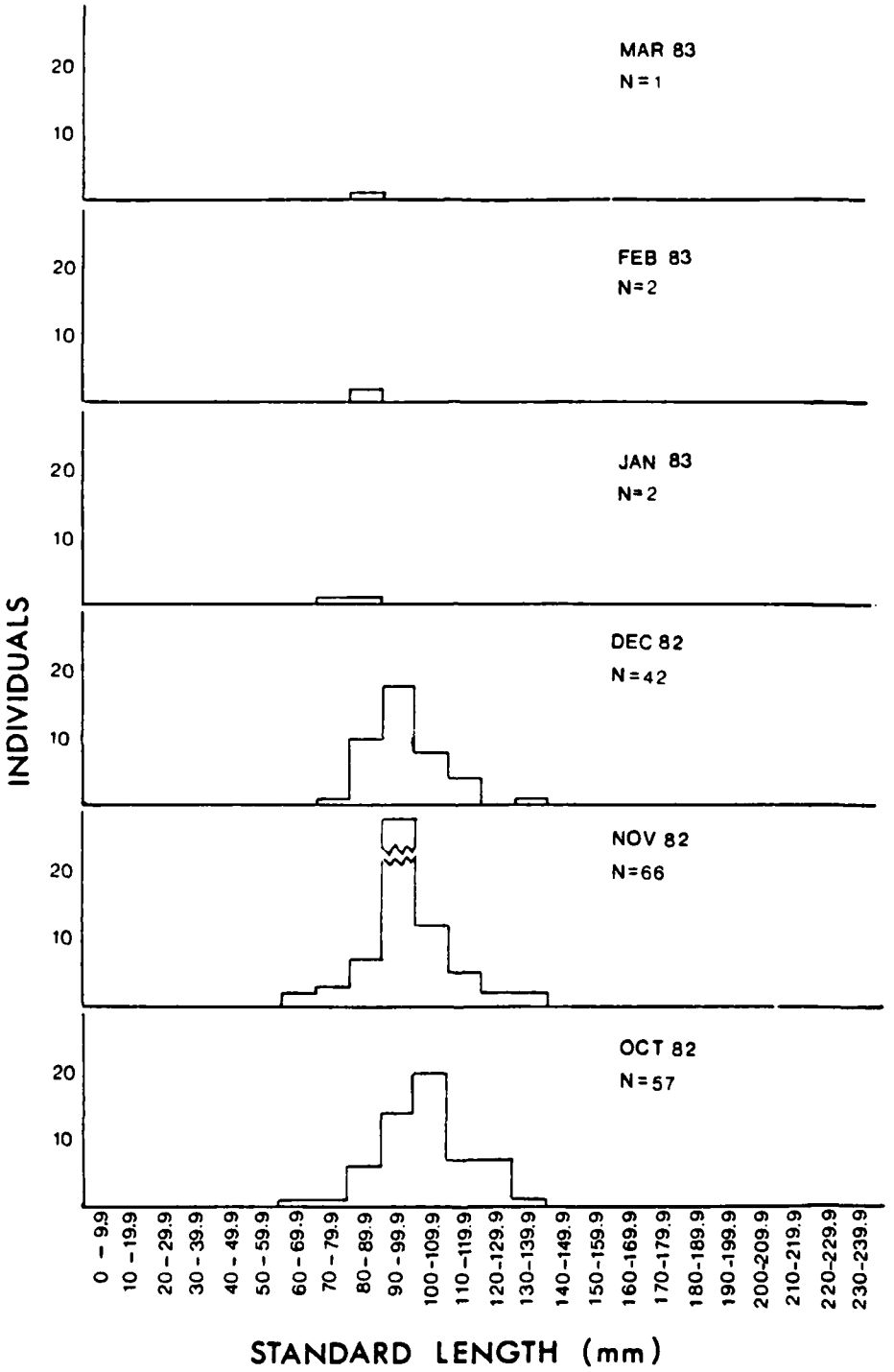

Fig. 16. Size frequency distribution of Leiostomus xanthurus (spot) at station 7 for October 1982 through March 1983.

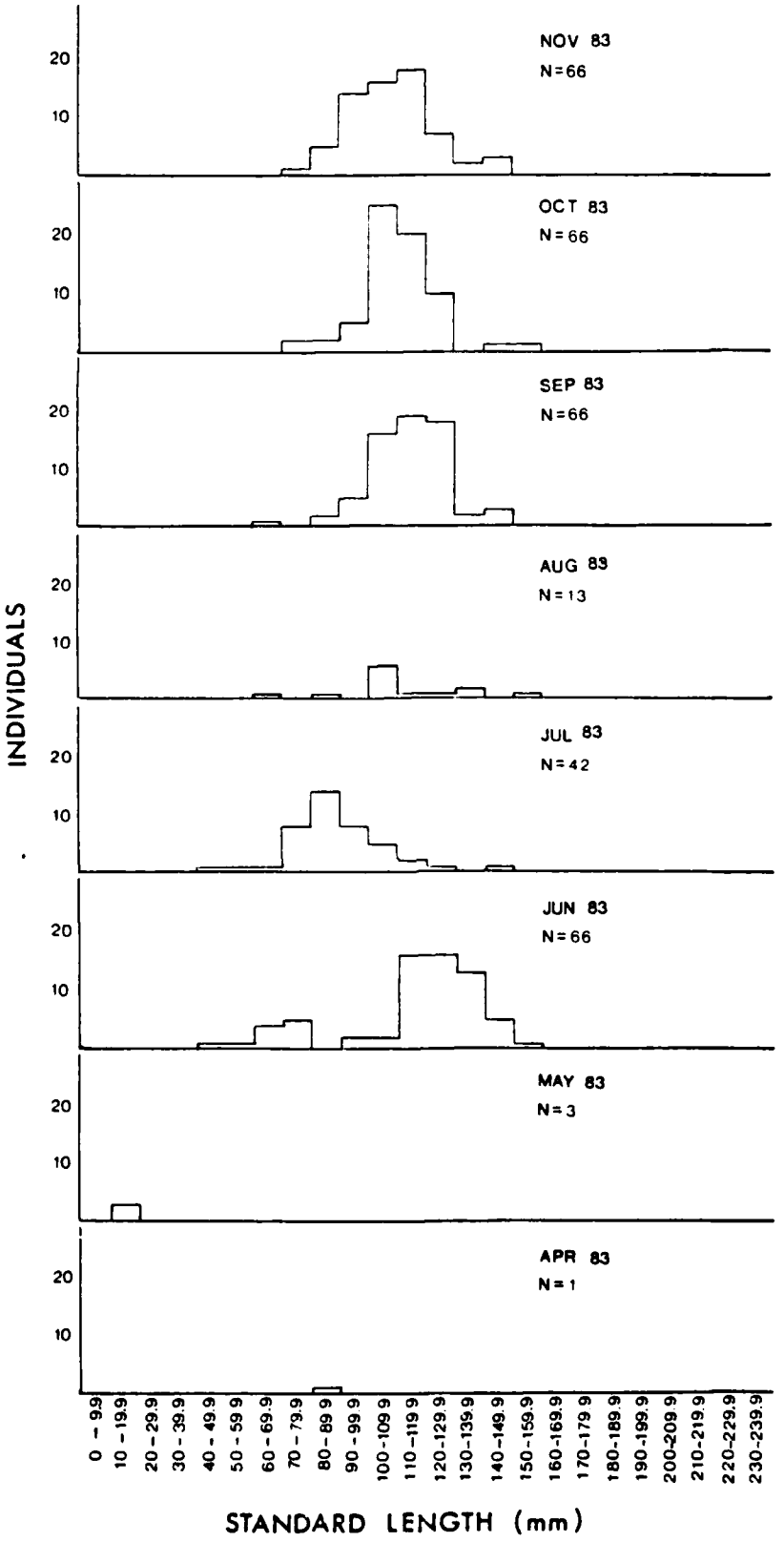

Fig. 17. Size frequency distribution of Leiostomus xanthurus (spot) at station 7 for April 1983 through November 1983.

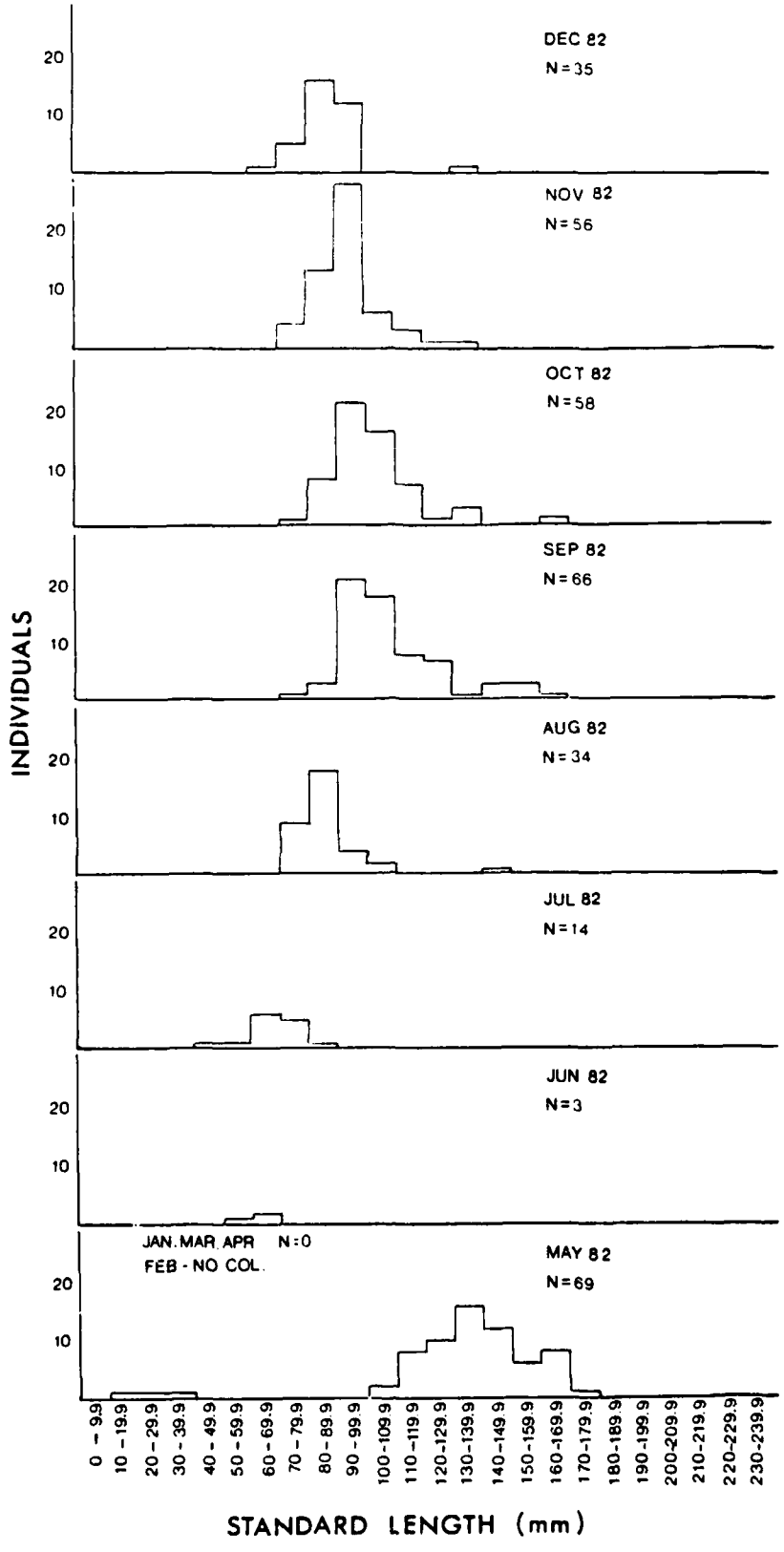

Fig. 18. Size frequency distribution of Leiostomus xanthurus (spot) at station 8 for May 1982 through December 1982.

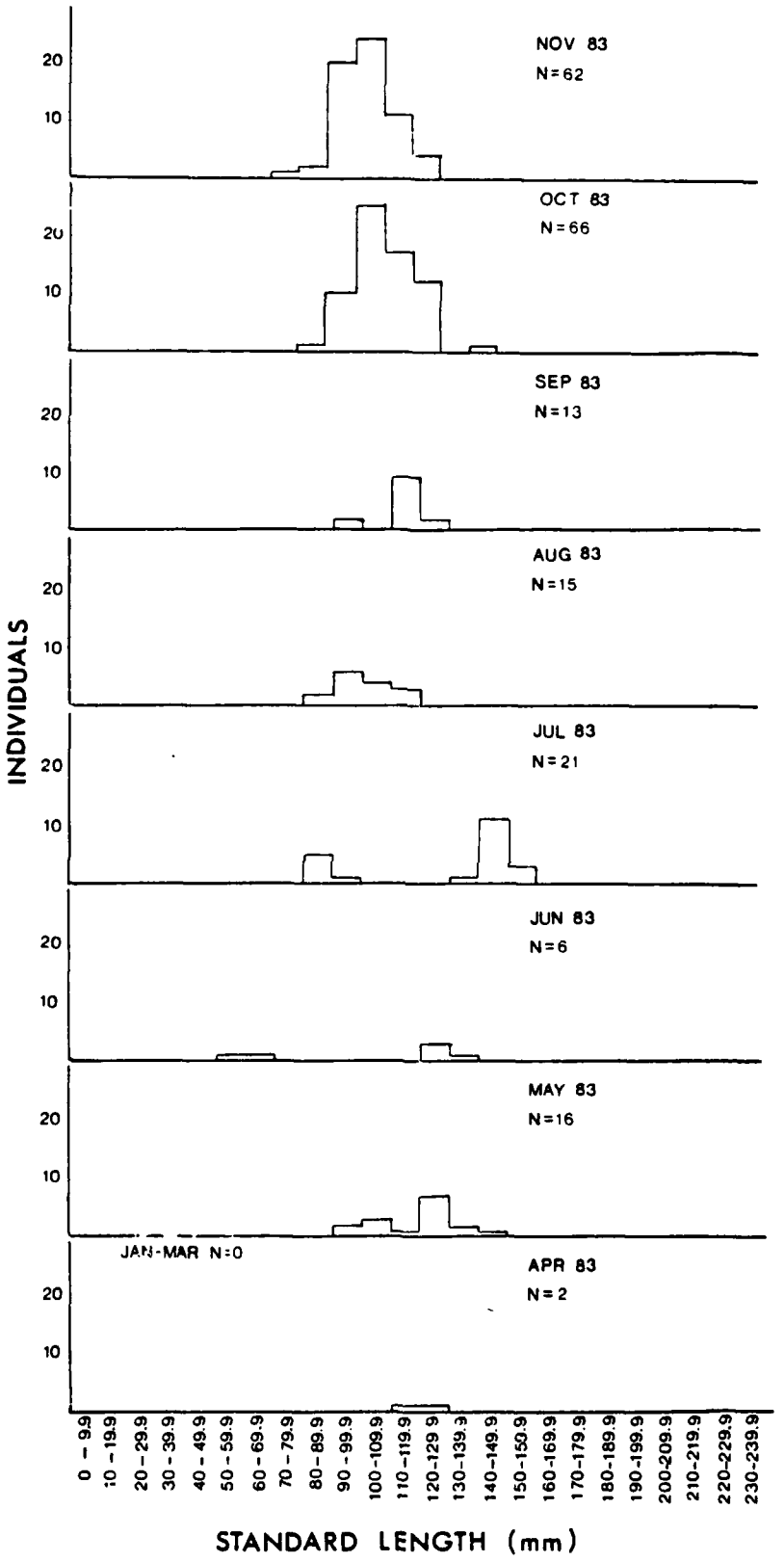

Fig. 19. Size frequency distribution of Leiostomus xanthurus (spot) at station 8 for April 1983 through November 1983.

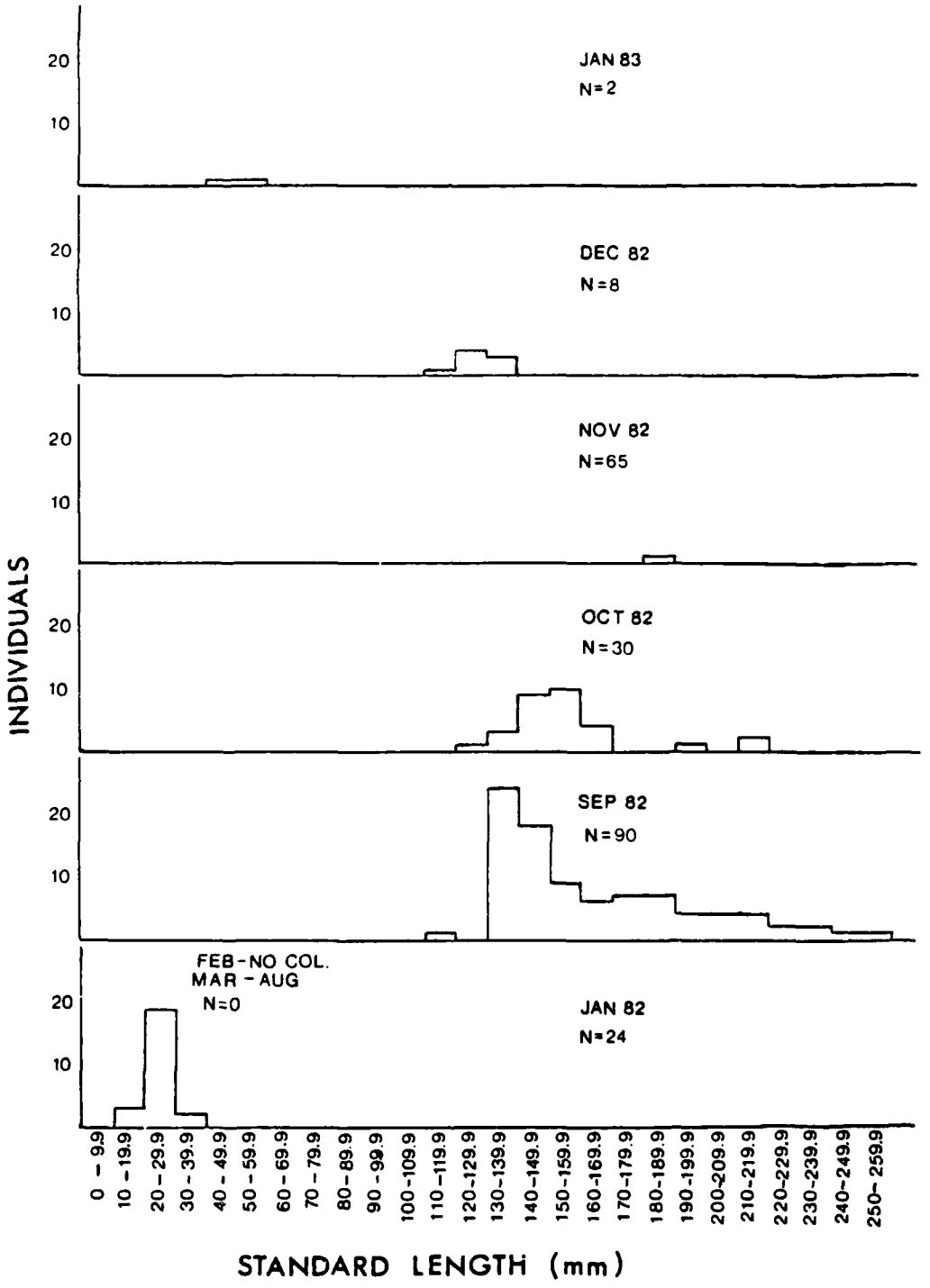

Fig. 20. Size frequency distribution of Micropogonias undulatus (croaker) at stations 1 through 4 (pooled) for February 1983 through November 1983.

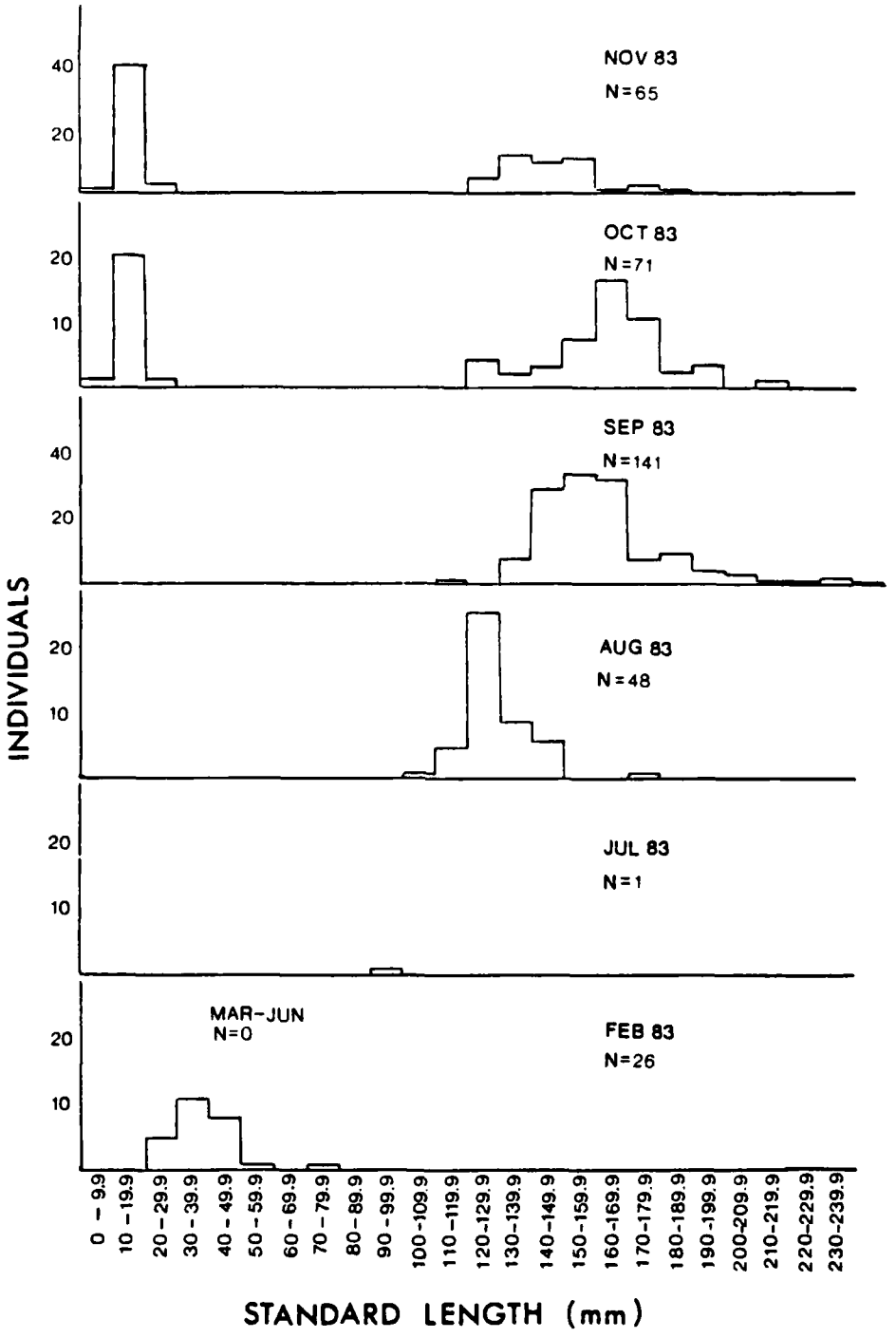

Fig. 21. Size frequency distribution of Micropogonias undulatus (croaker) at stations 1 through 4 (pooled) for January 1983 through January 1983.

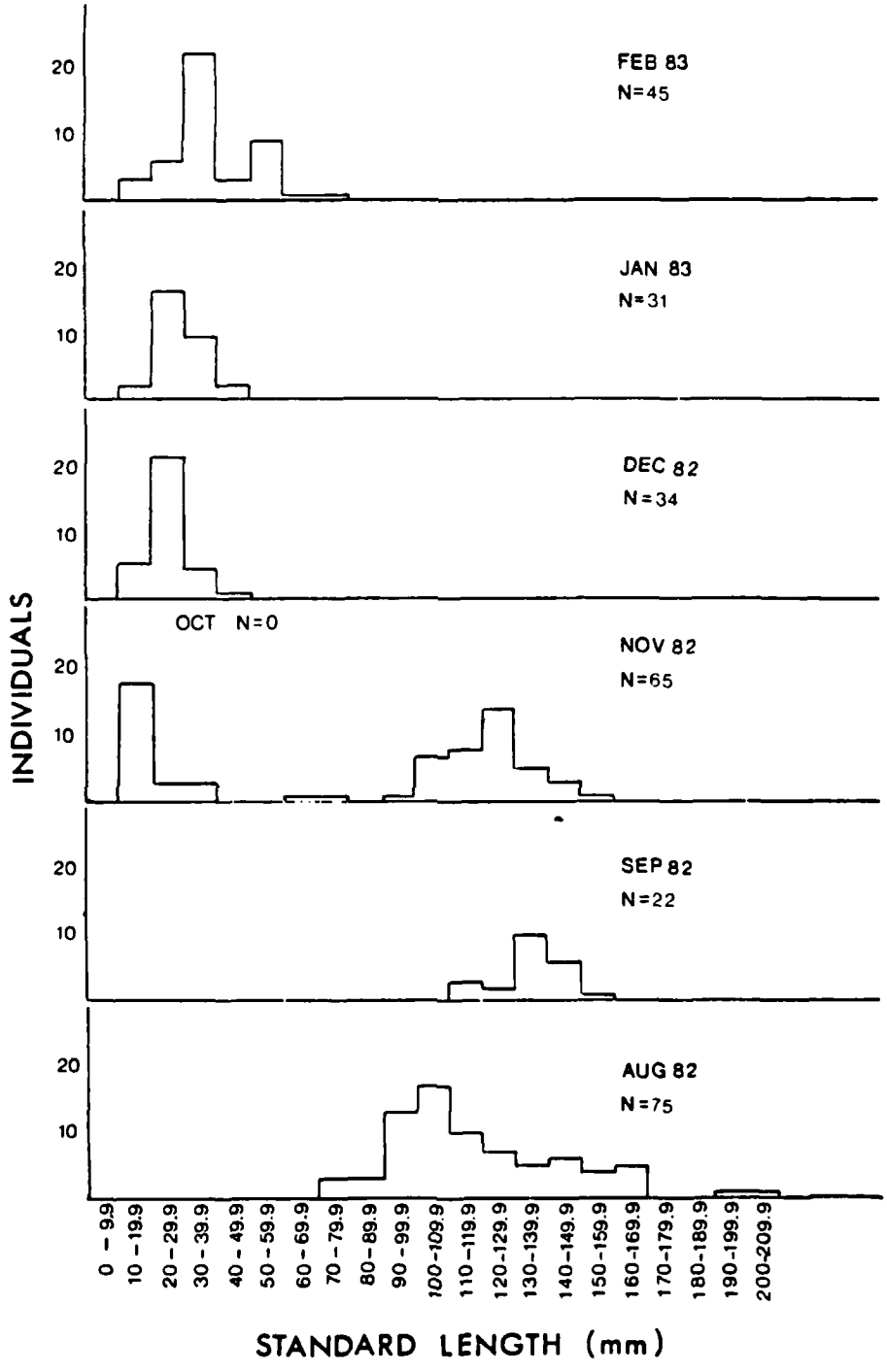

Fig. 23. Size frequency distribution of Micropogonias undulatus (croaker) at stations 5 and 6 (pooled) for August 1982 through February 1983.

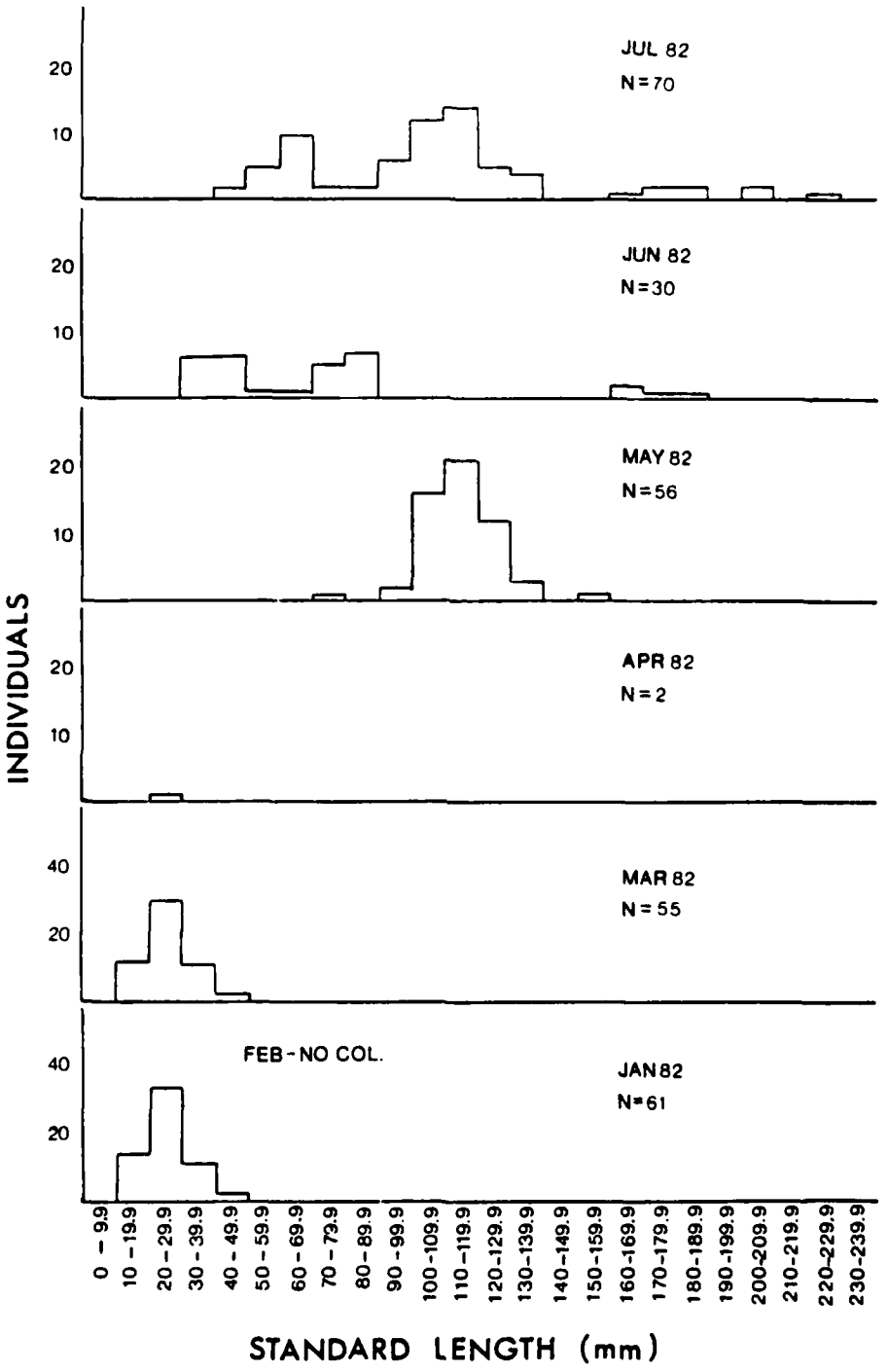

Fig. 22. Size frequency distribution of Micropogonias undulatus (croaker) at stations 5 and 6 (pooled) for January 1982 through July 1982.

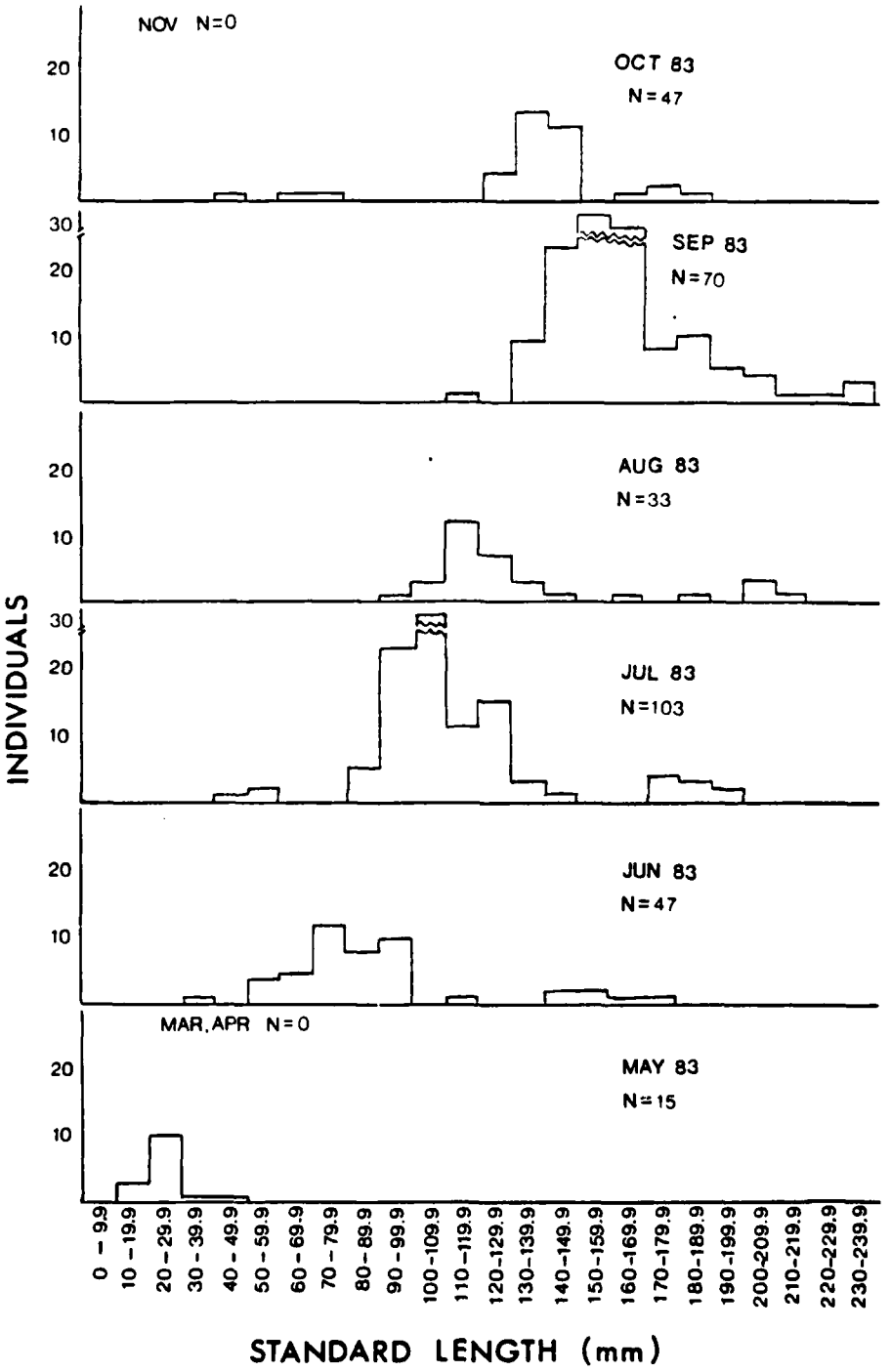

Fig. 24. Size frequency distribution of Micropogonias undulatus (croaker) at stations 5 and 6 (pooled) for May 1983 through October 1983.

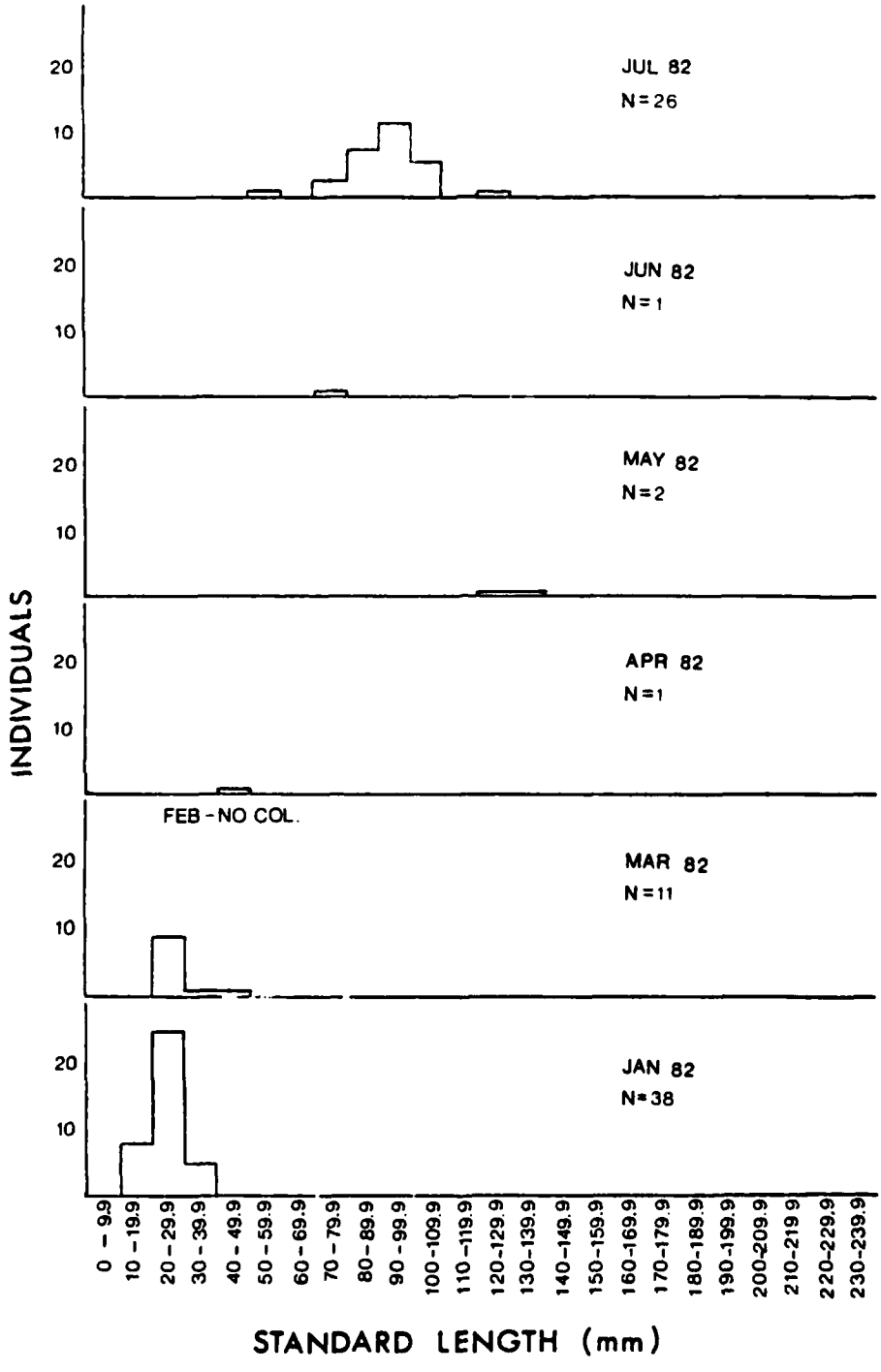

Fig. 25. Size frequency distribution of Micropogonias undulatus (croaker) at station 7 for January 1982 through July 1982.

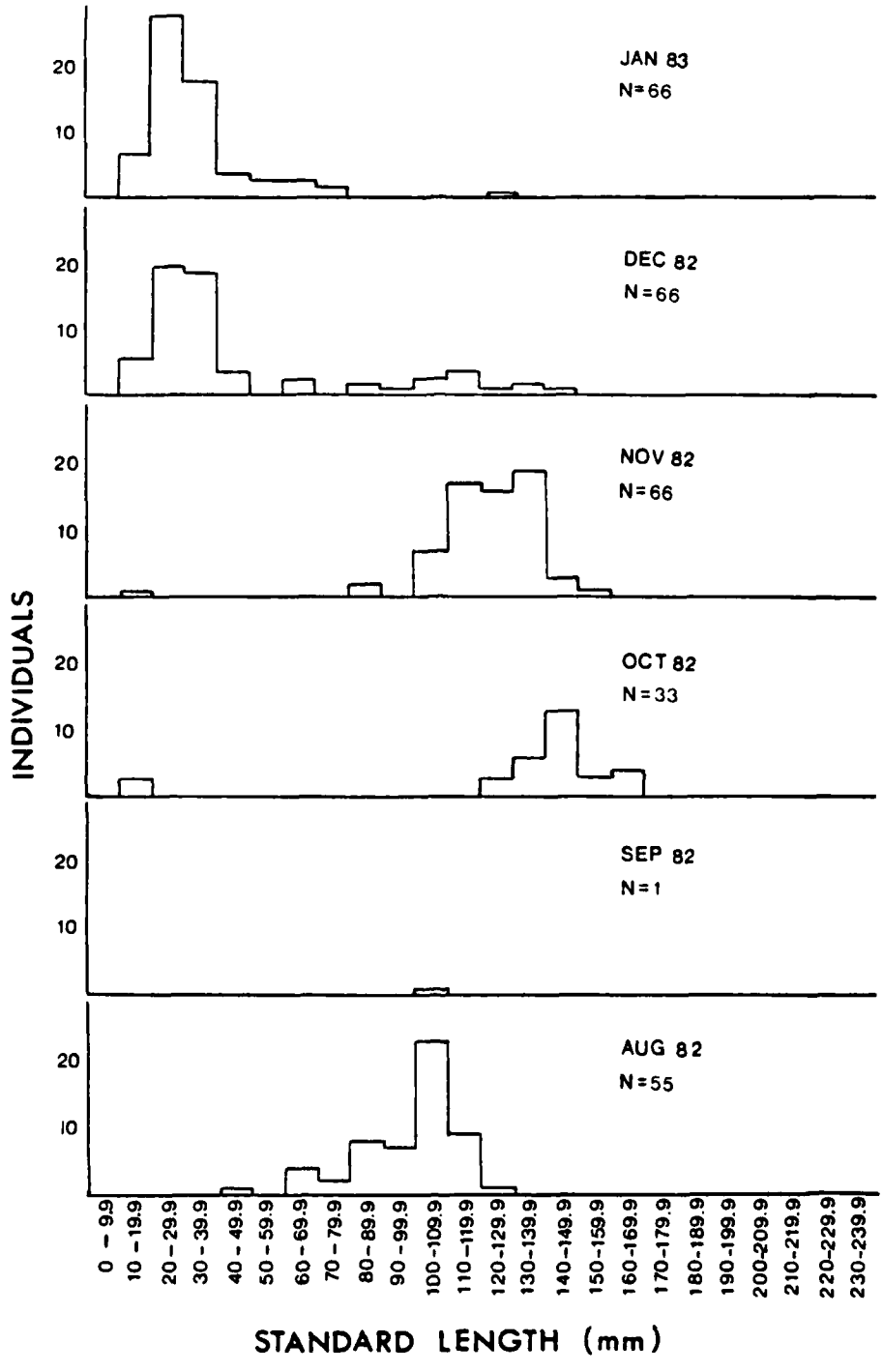

Fig. 26. Size frequency distribution of Micropogonias undulatus (croaker) at station 7 for August 1982 through January 1983.

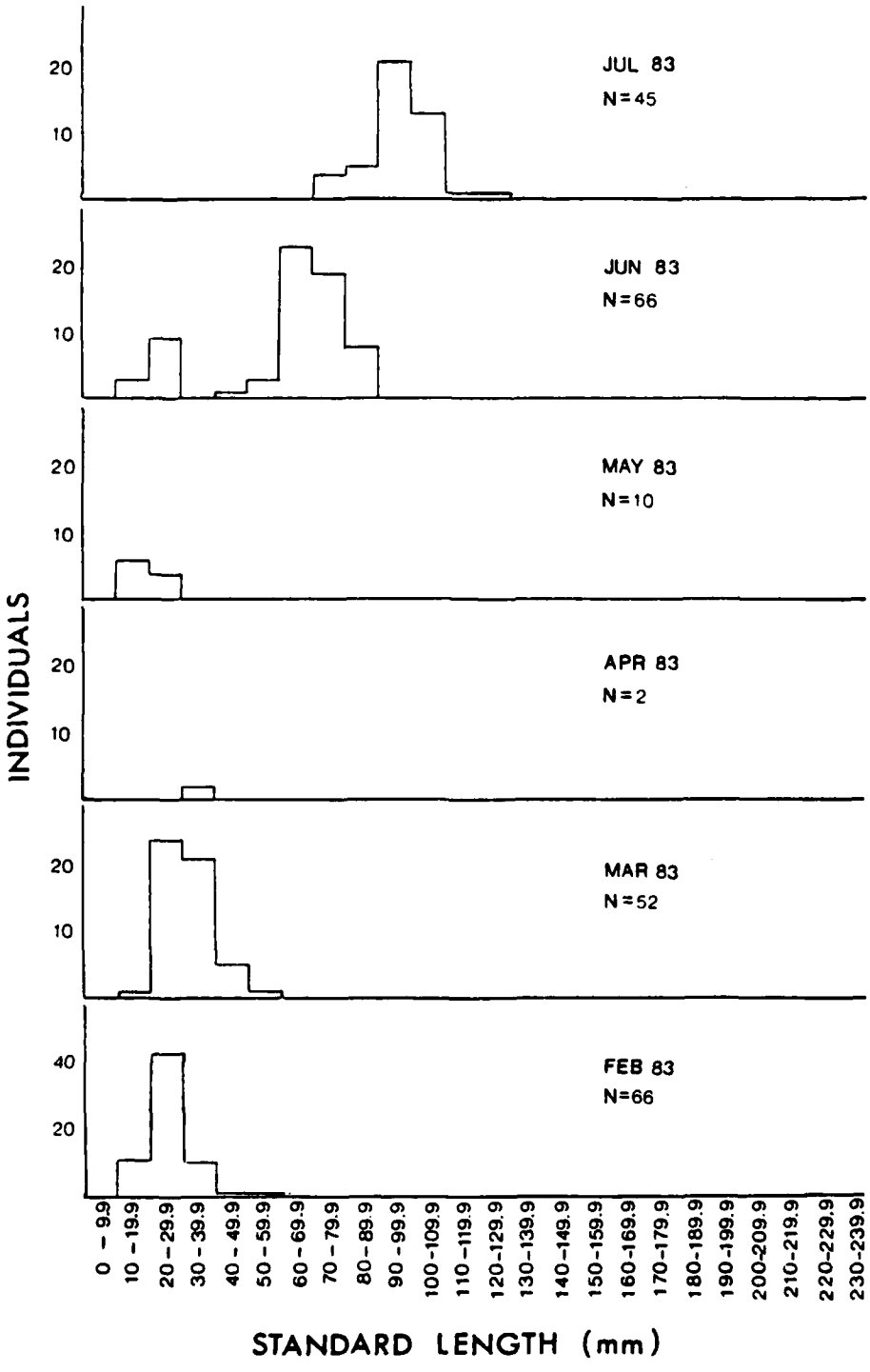

Fig. 27. Size frequency distribution of Micropogonias undulatus (croaker) at station 7 for February 1982 through July 1983.

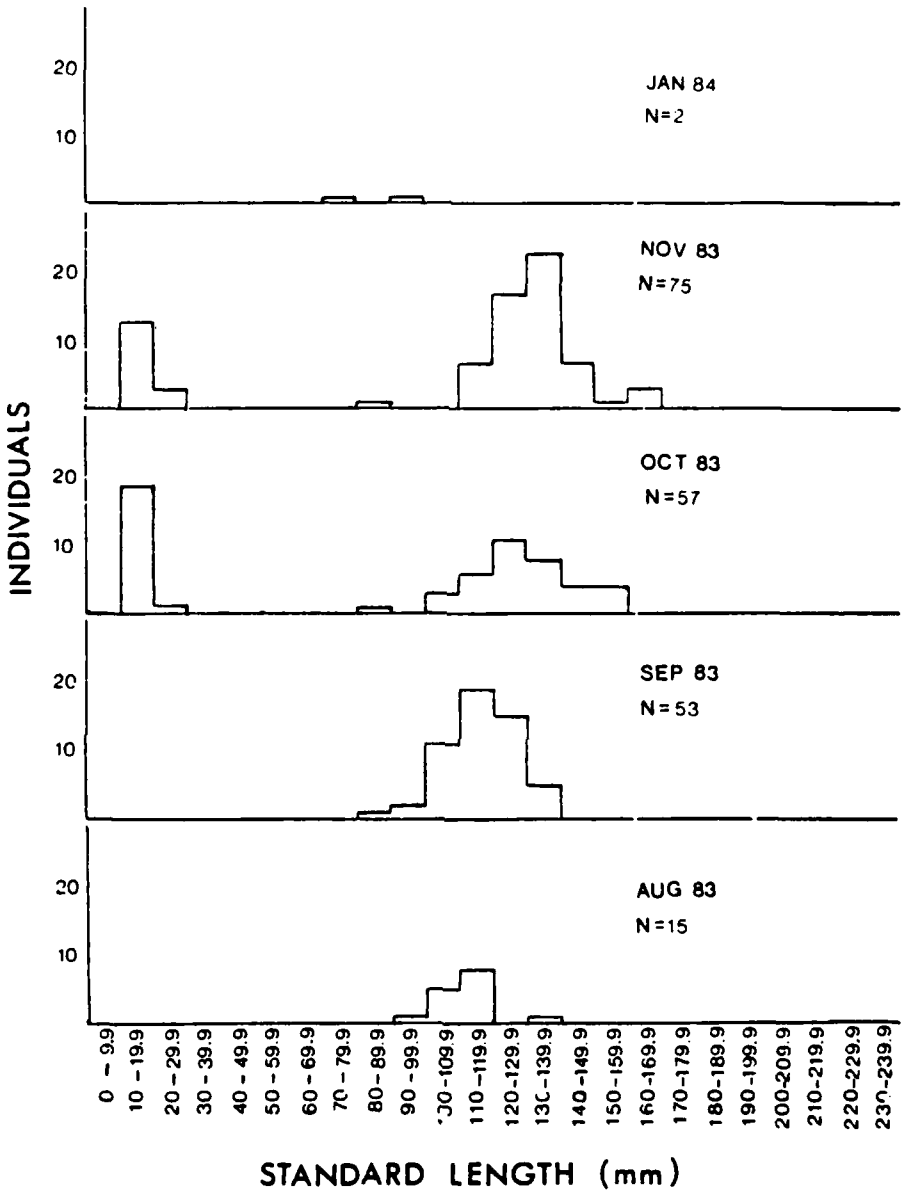

Fig. 28. Size frequency distribution of Micropogonias undulatus (croaker) at station 7 for August 1983 through Januray 1984.

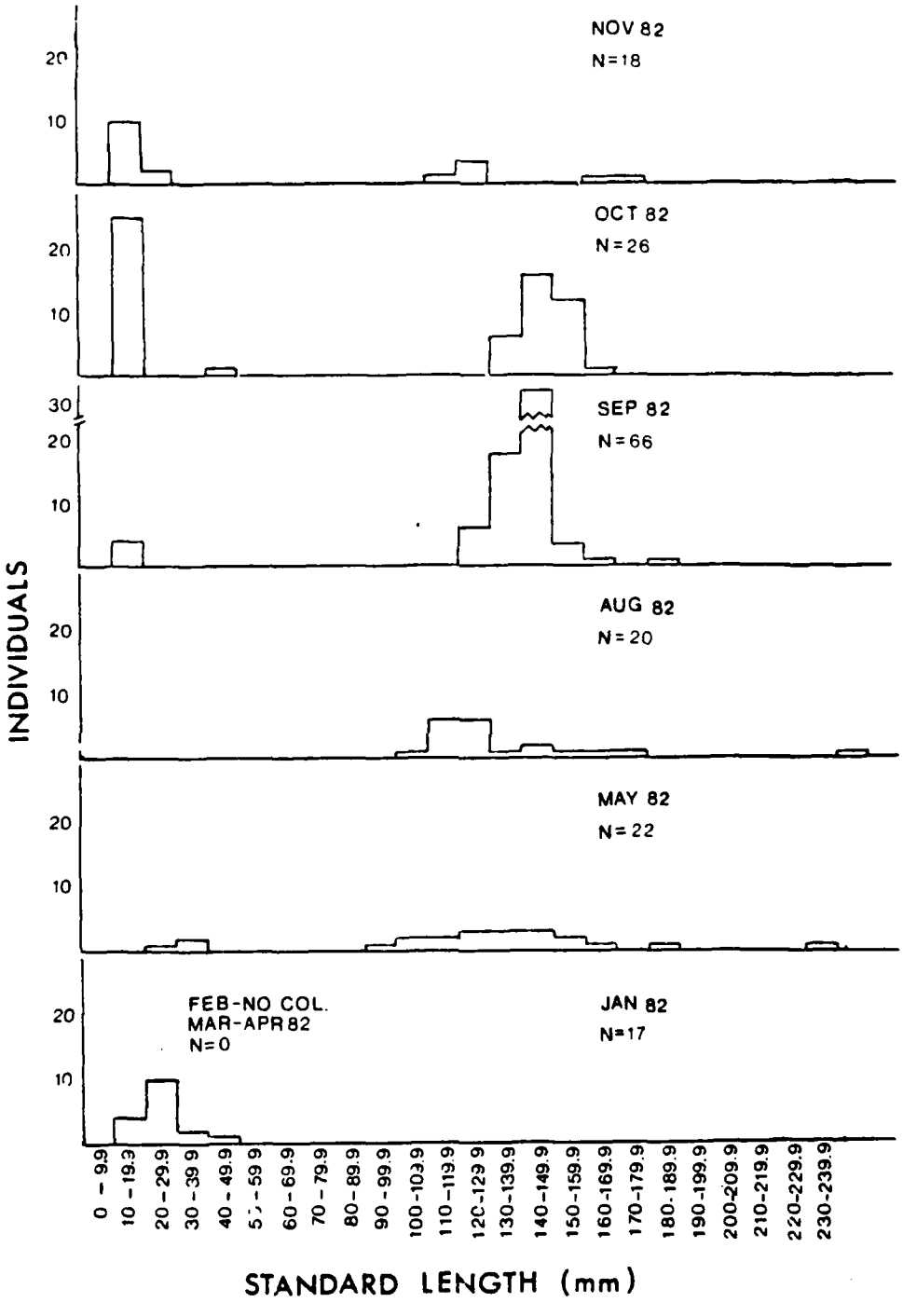

Fig. 29. Size frequency distribution of Micropogonias undulatus (croaker) at station 8 for January 1982 through November 1982.

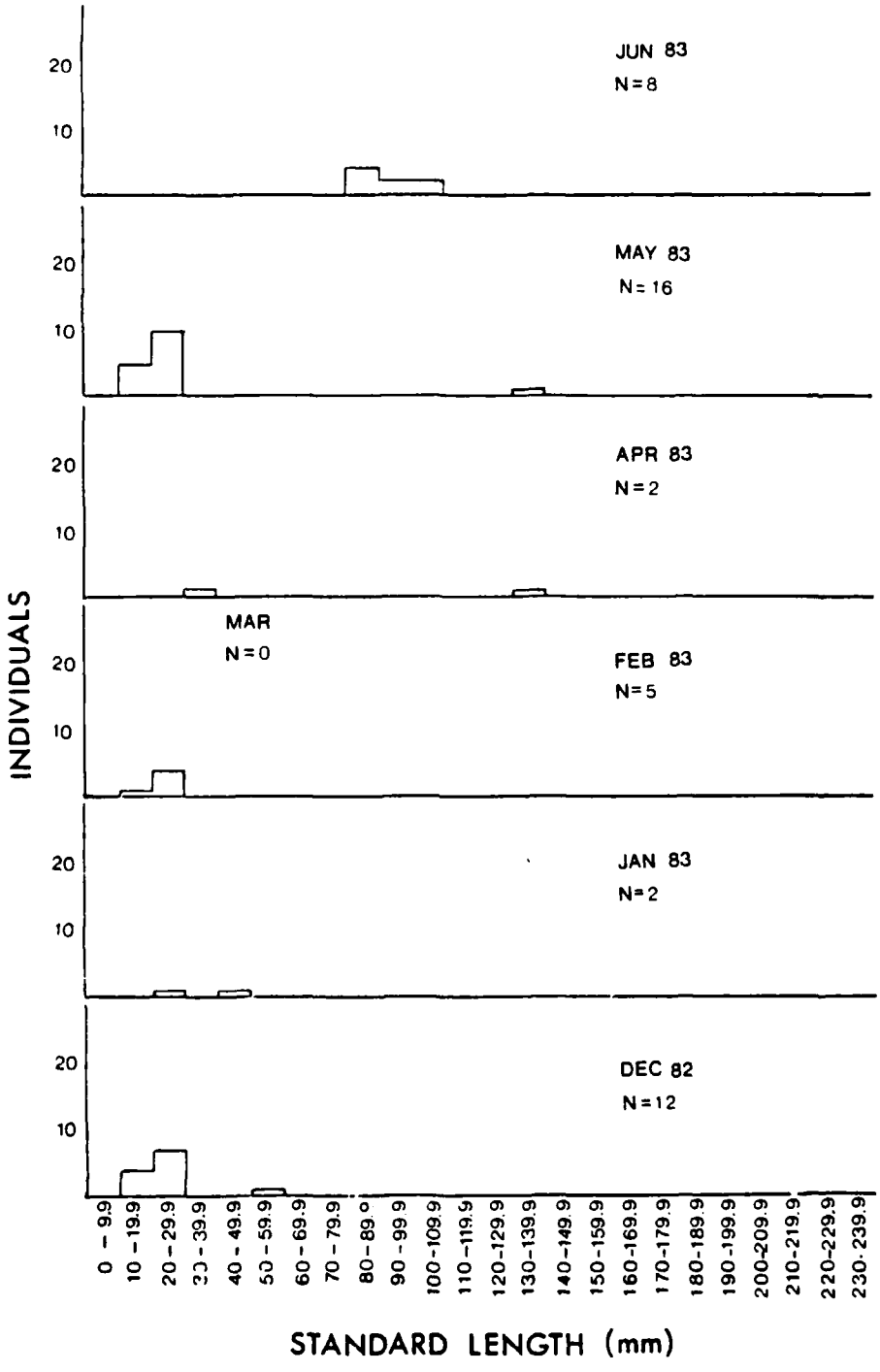

Fig. 30. Size frequency distribution of Micropogonias undulatus (croaker) at station 8 for December 1982 through June 1983.

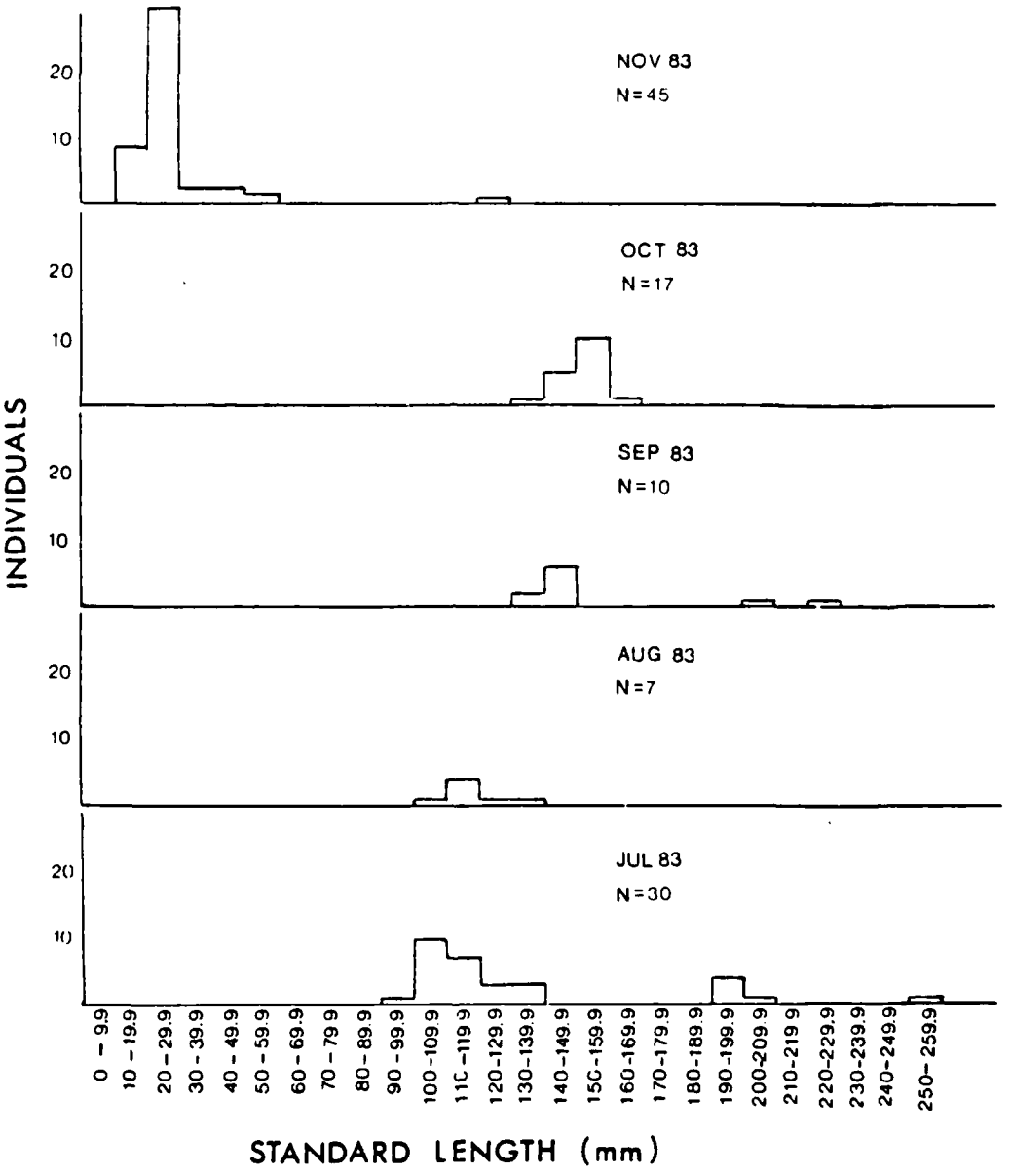

Fig. 31. Size frequency distribution of Micropogonias undulatus (croaker) at station 8 for July 1983 through November 1983.

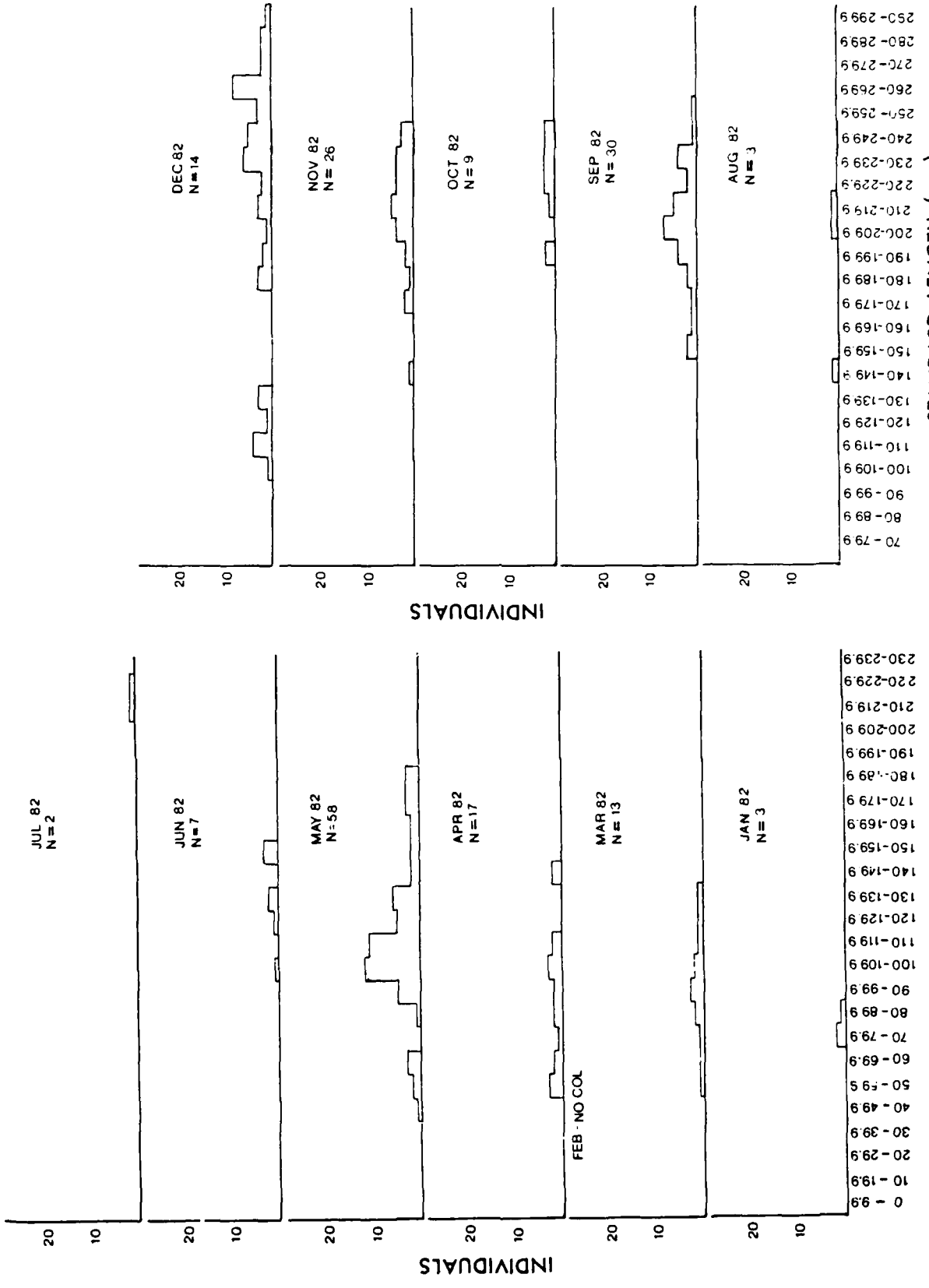

Fig. 32. Size frequency distribution of Urophycis regia (spotted hake) at stations 1 through 4 (pooled) for January 1982 through December 1982.

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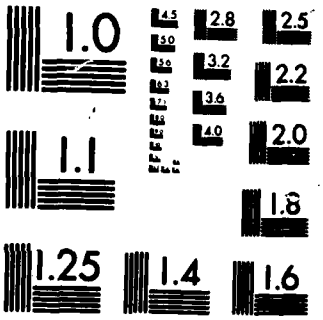

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NATIONAL BUREAU OF STANDARDS-1963-A

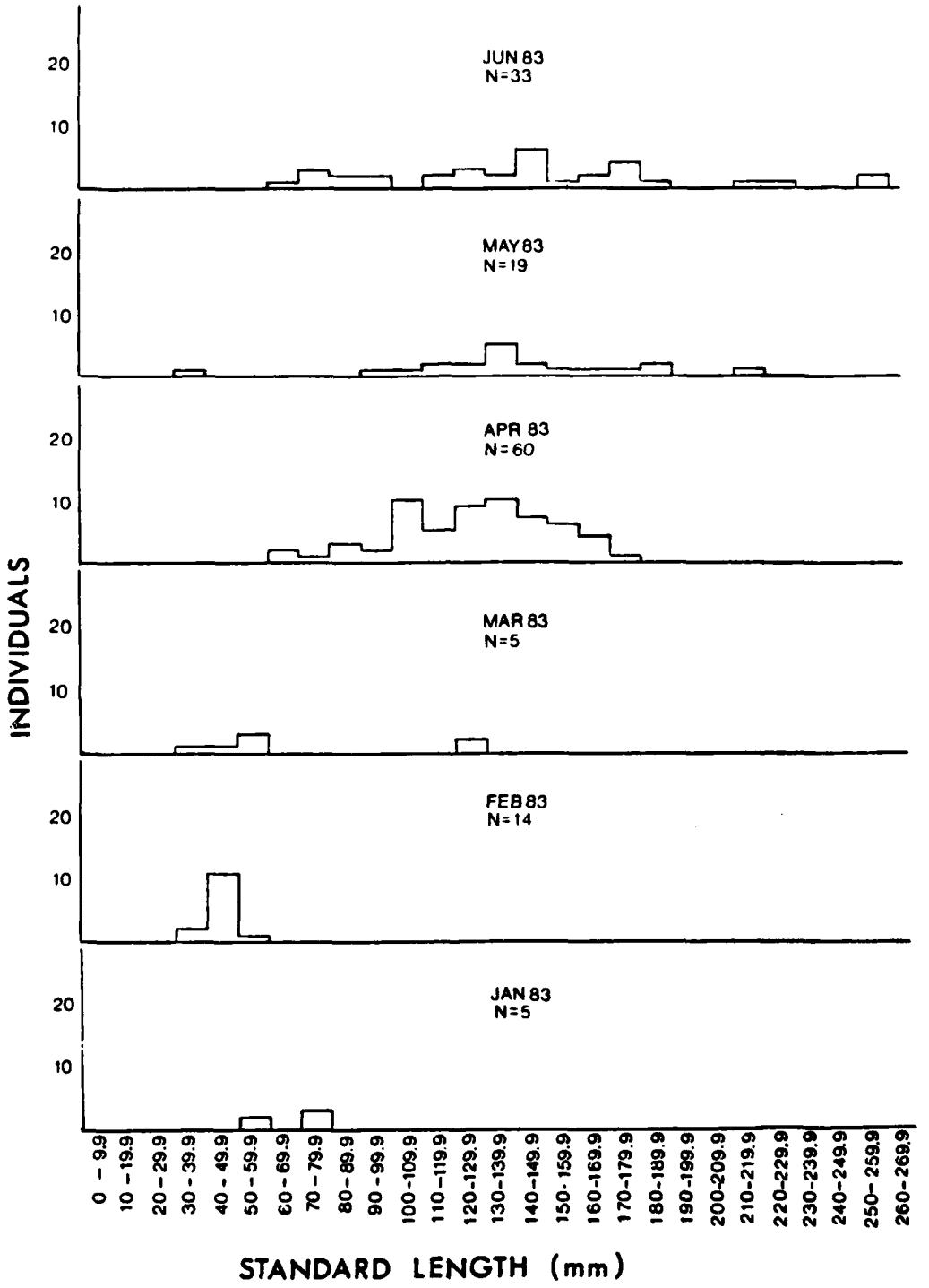

Fig. 33. Size frequency distribution of Urophycis regia (spotted hake) at stations 1 through 4 (pooled) for January 1983 through June 1983.

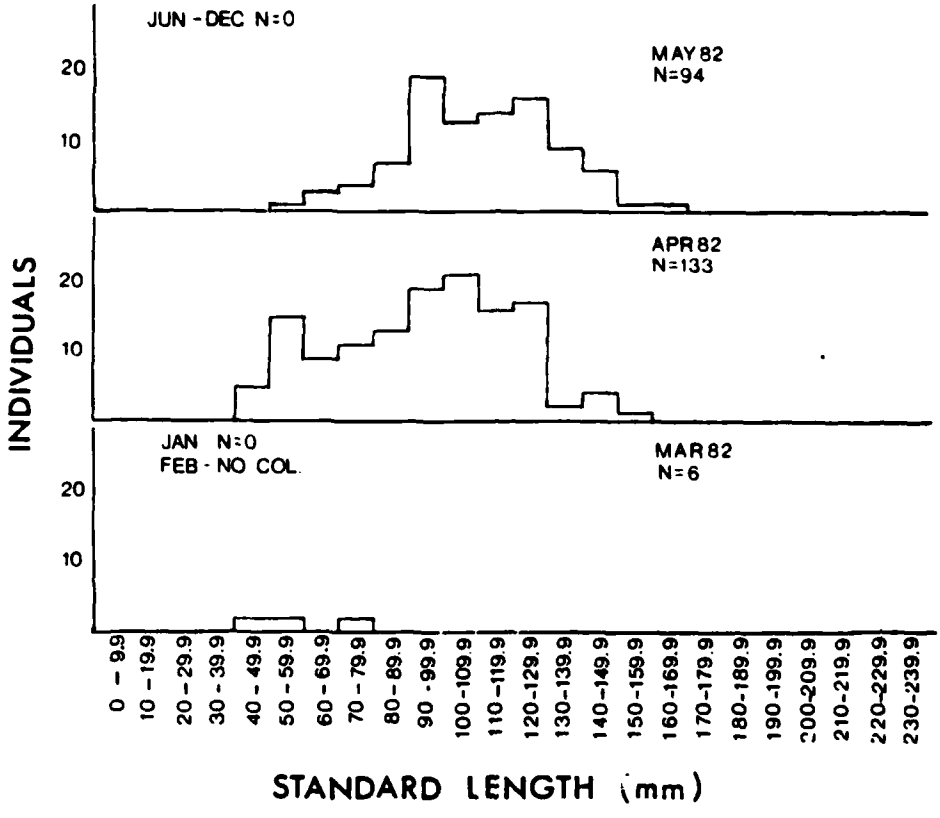

Fig. 34. Size frequency distribution of Urophycis regia (spotted hake) at stations 5 and 6 (pooled) for April 1982 through May 1982.

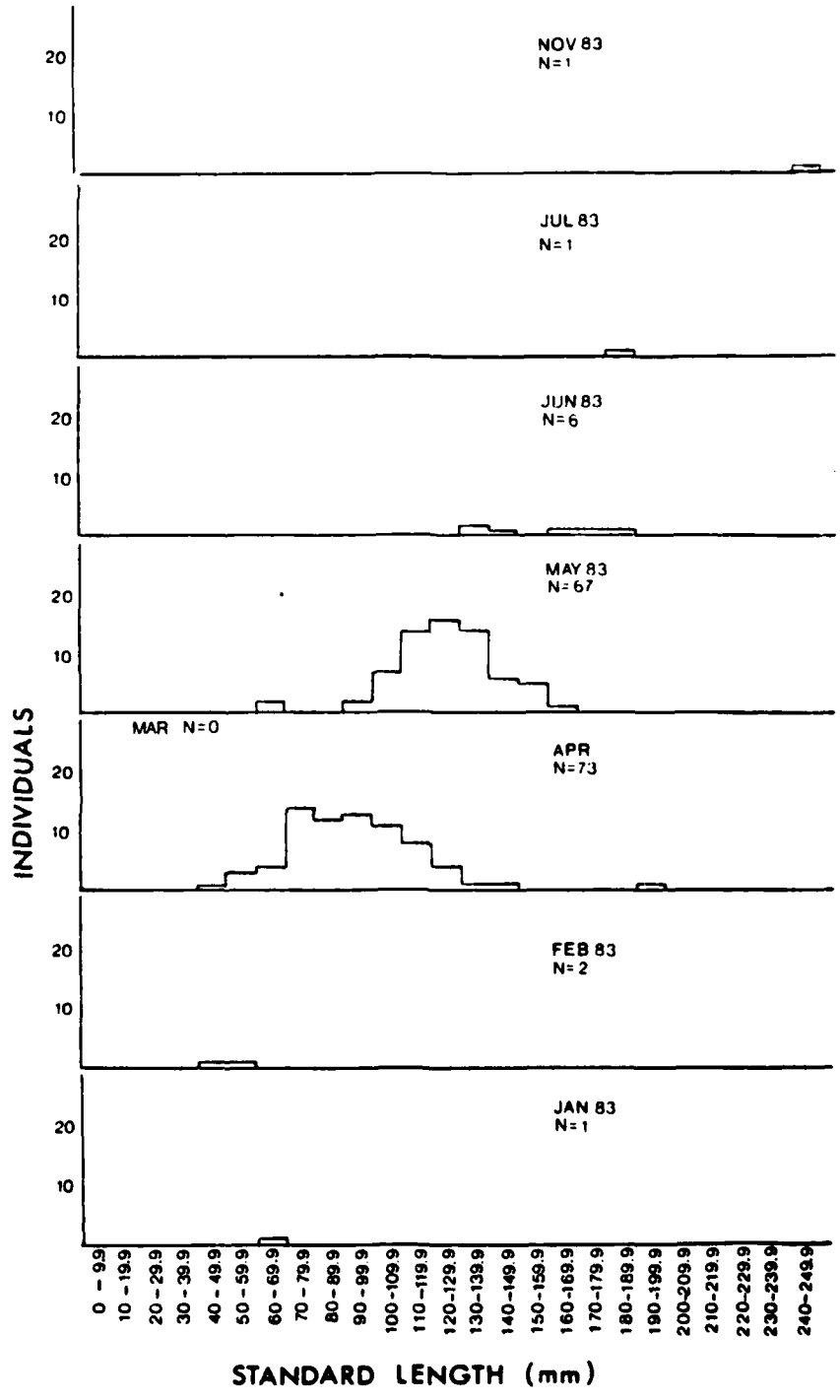

Fig. 35. Size frequency distribution of Urophycis regia (spotted hake) at stations 5 and 6 (pooled) for January 1983 through November 1983.

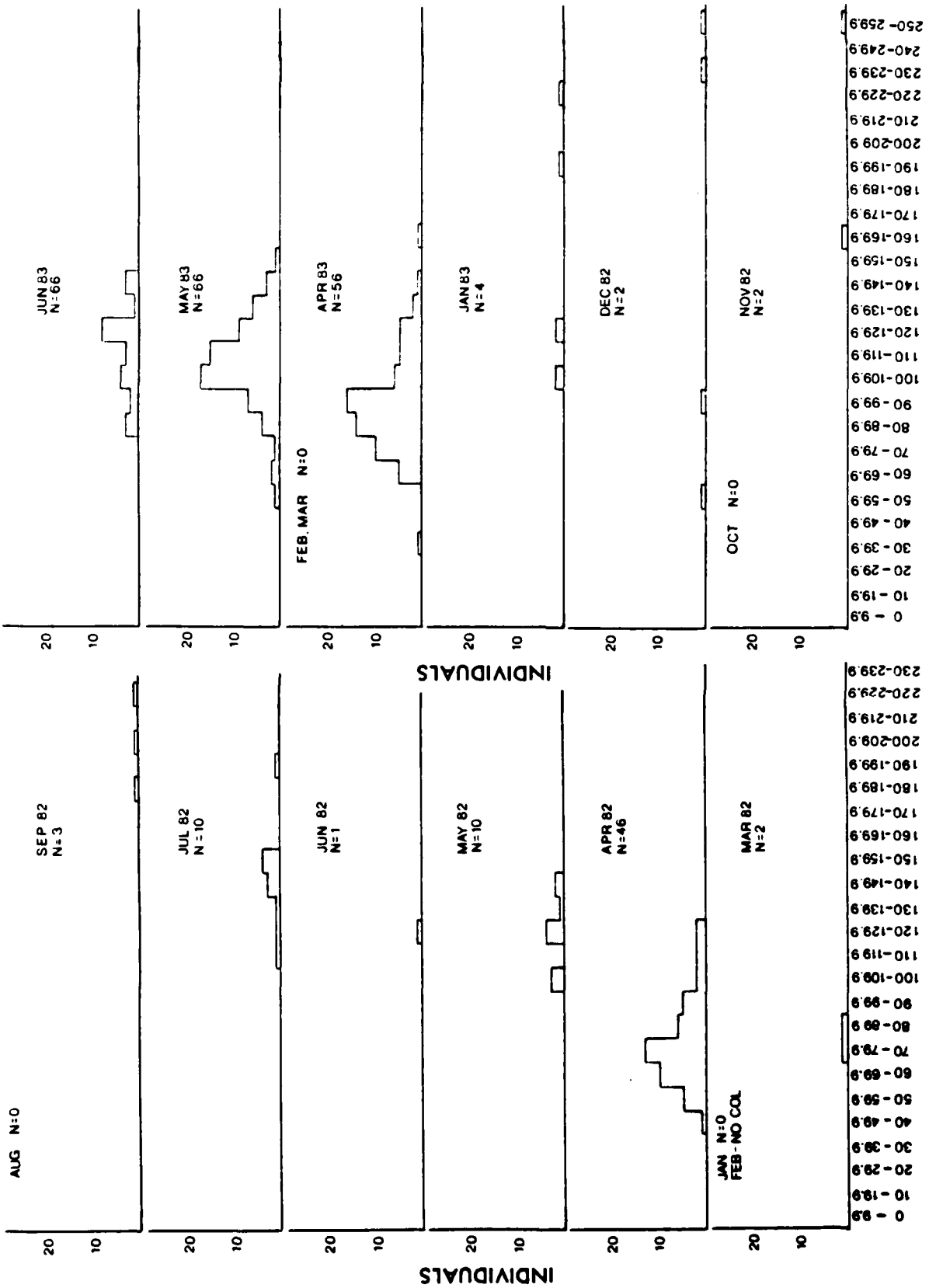

Fig. 36. Size frequency distribution of Urophycis regia (spotted hake) at station 7 for March 1982 through June 1983.

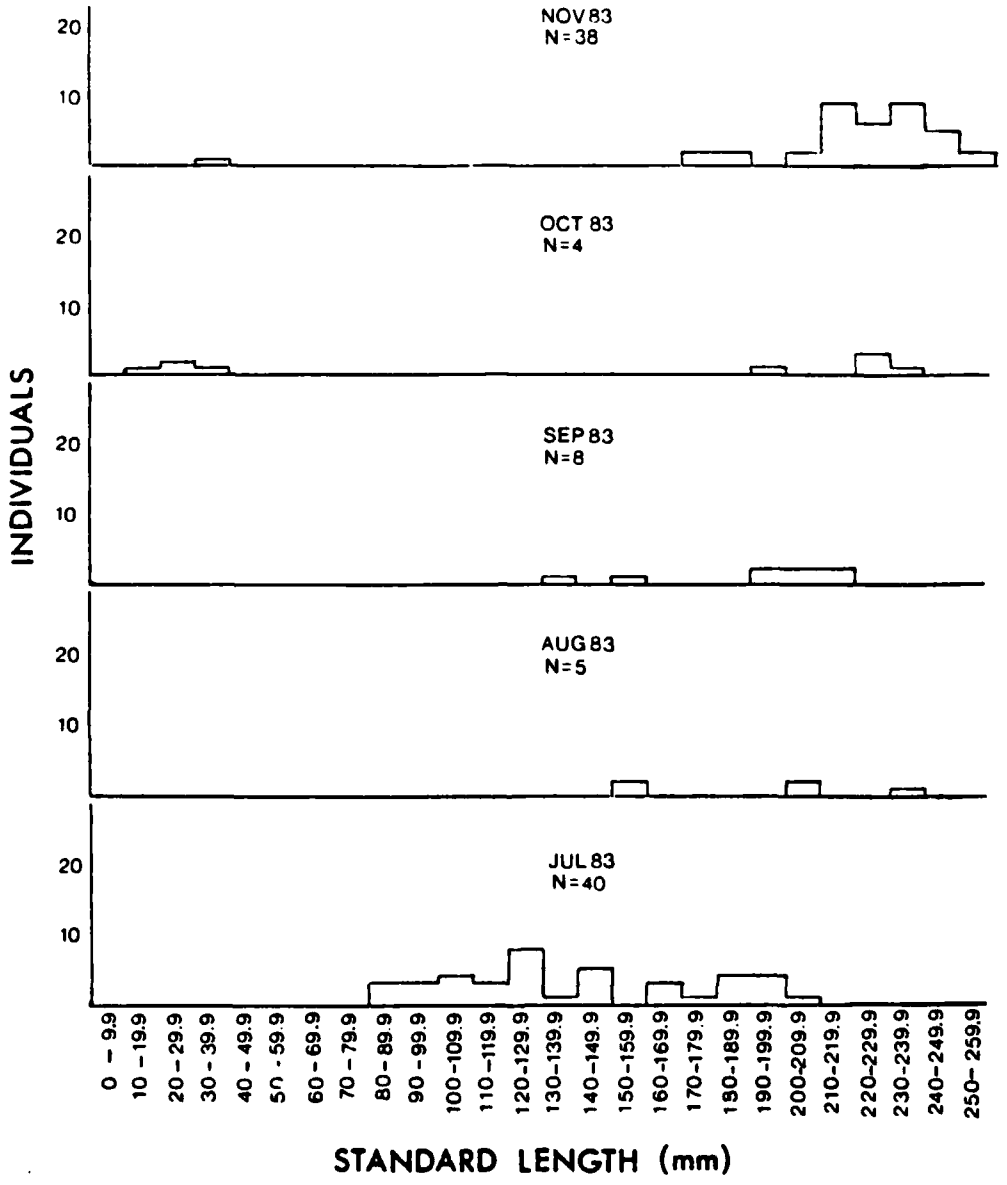

Fig. 37. Size frequency distribution of Urophycis regia (spotted hake) at stations 1 through 4 (pooled) for July 1983 through November 1983.

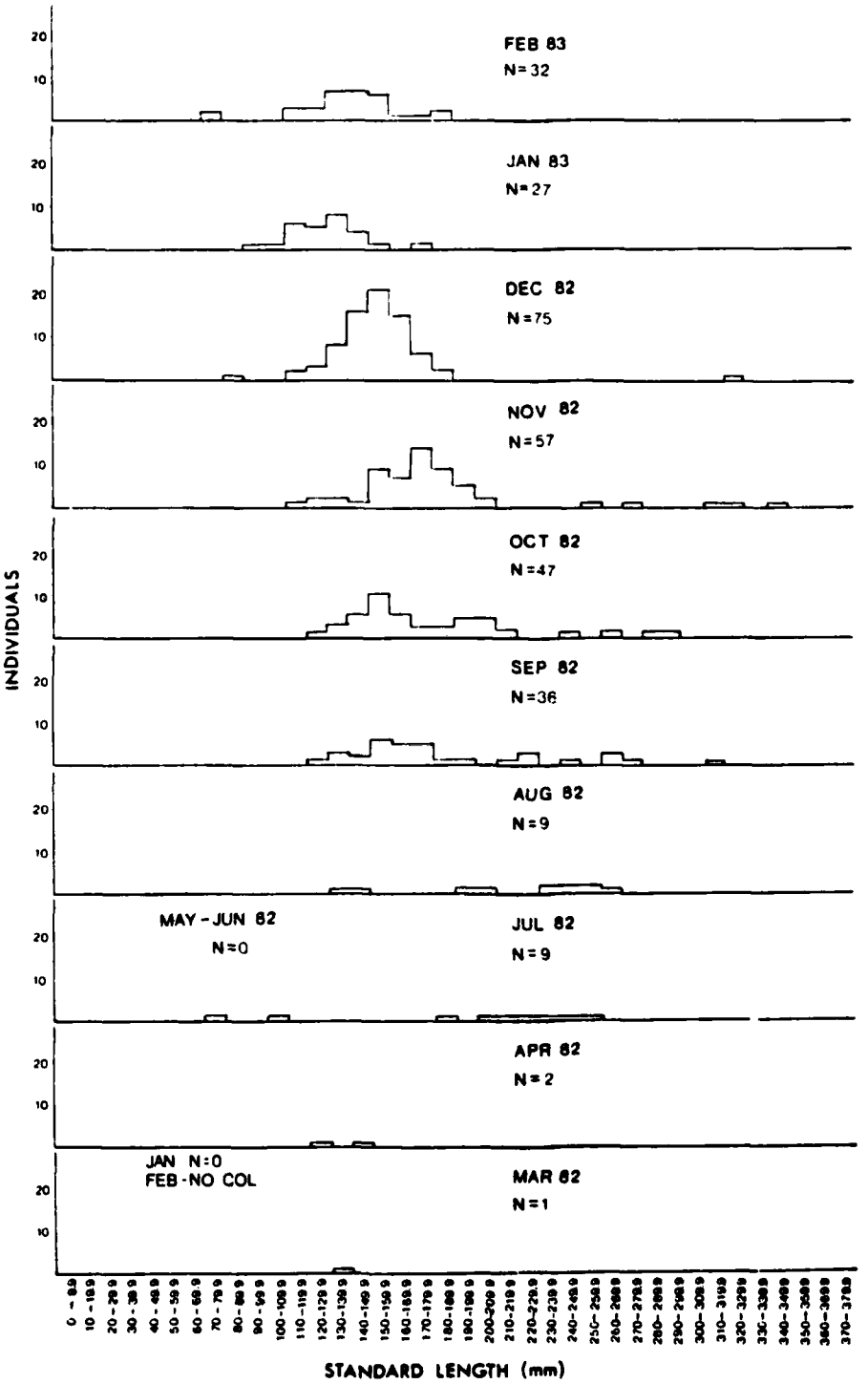

Fig. 38. Size frequency distribution of Paralichthys dentatus (summer flounder) at stations 1 through 4 (pooled) for March 1982 through February 1983.

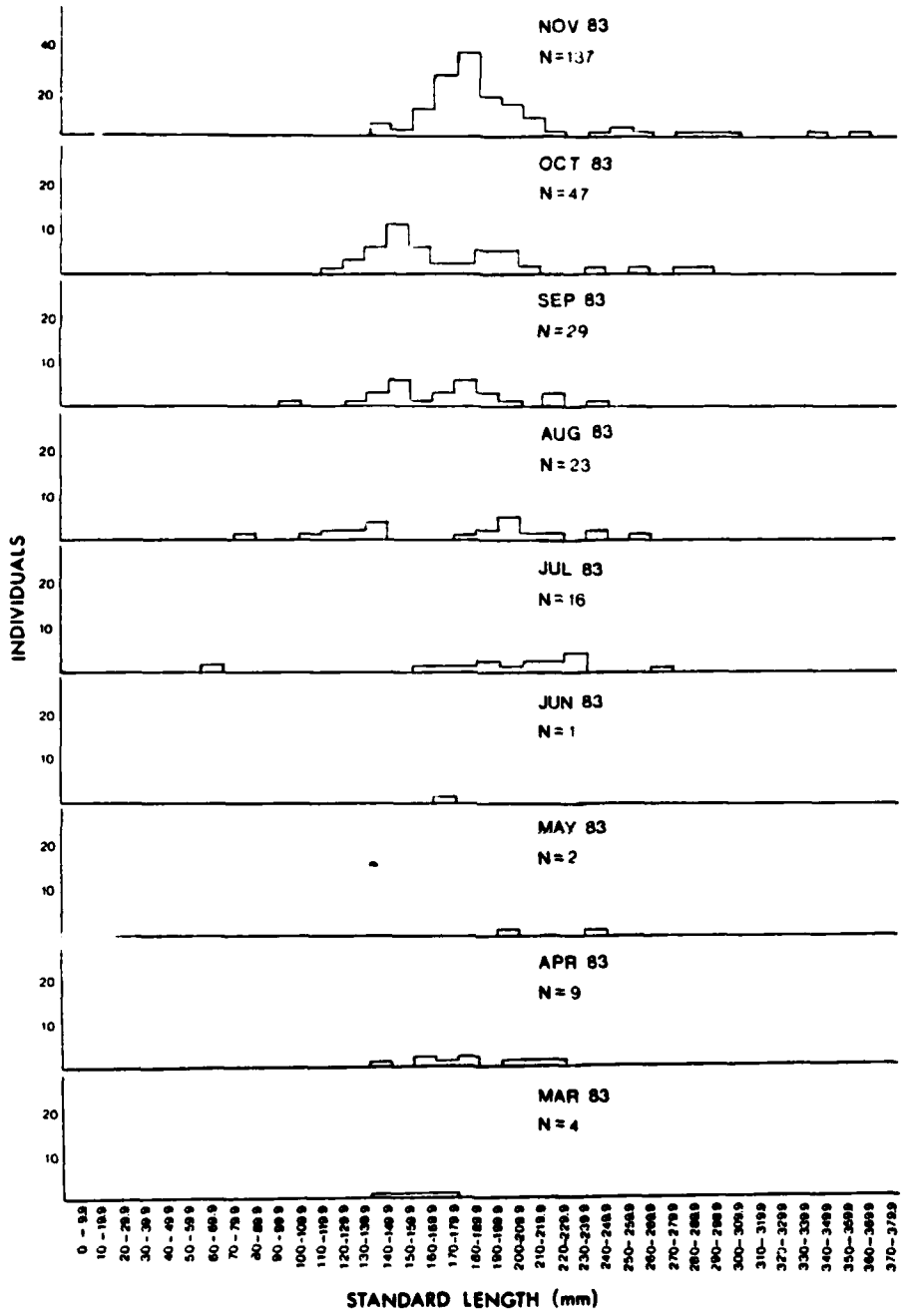

Fig. 39. Size frequency distribution of Paralichthys dentatus (summer flounder) at stations 1 through 4 (pooled) for March 1983 through November 1983.

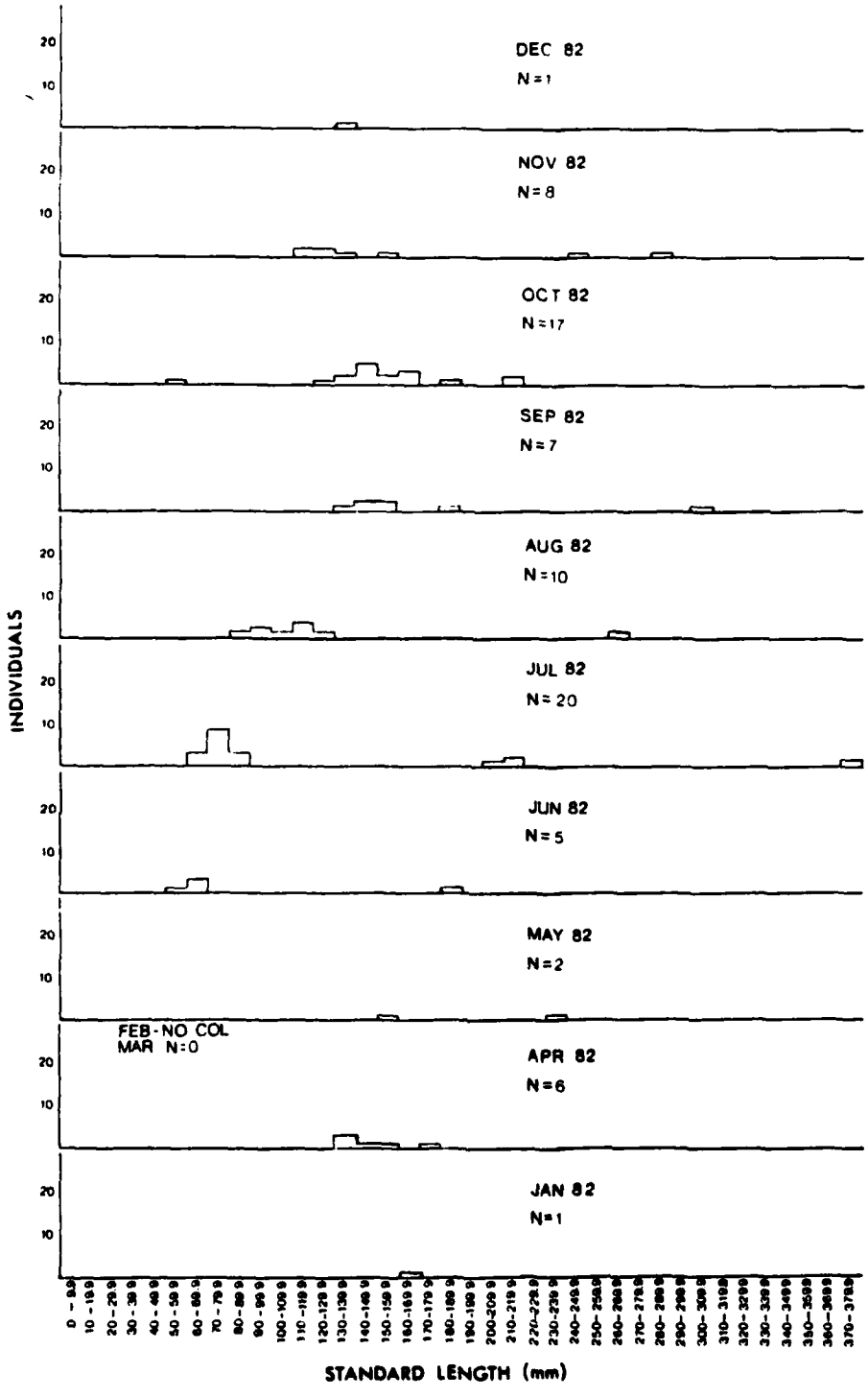

Fig. 40. Size frequency distribution of Paralichthys dentatus (summer flounder) at stations 5 and 6 (pooled) for January 1982 through December 1982.

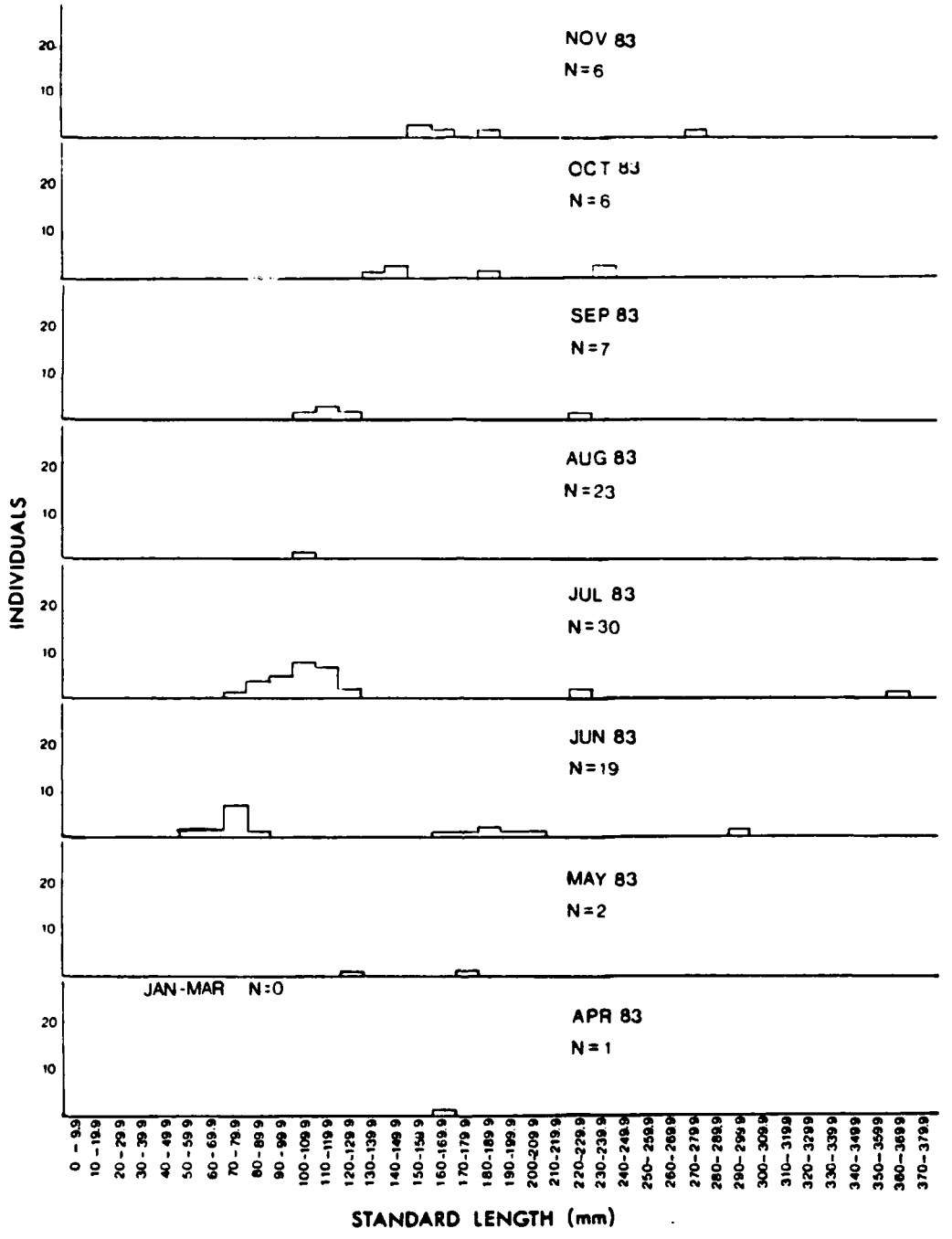

Fig. 41. Size frequency distribution of Paralichthys dentatus (summer flounder) at stations 5 and 6 (pooled) for April 1983 through November 1983.

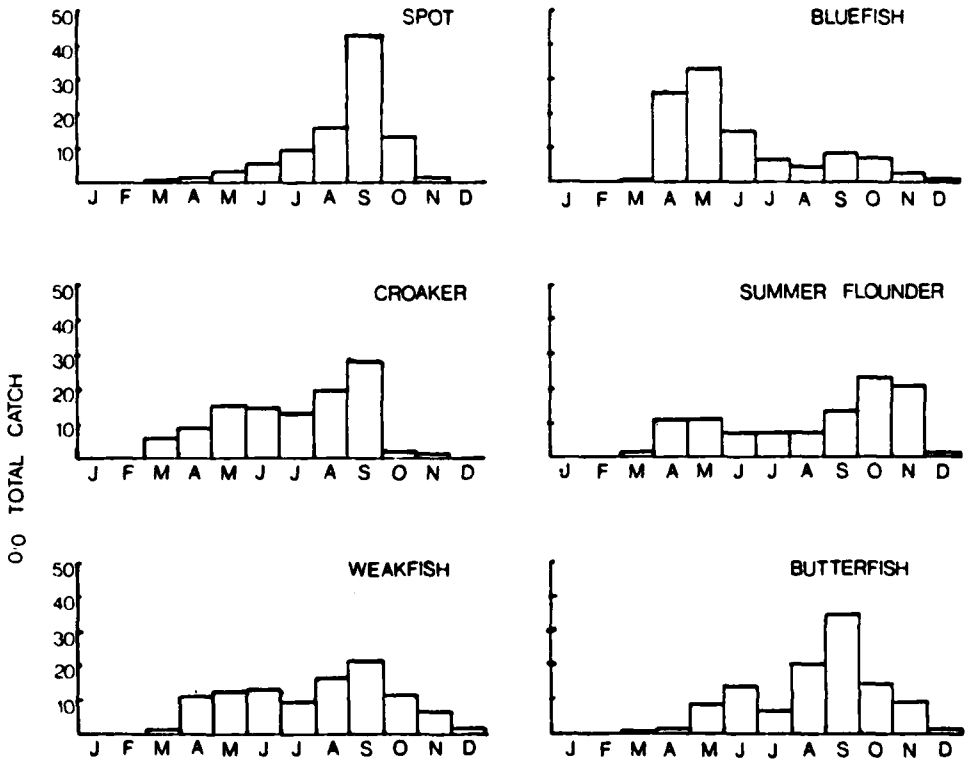

Fig. 42. Average monthly distribution of commercial catch in lower Chesapeake Bay, NMFS reporting area 311, for spot, bluefish, croaker, summer flounder, weakfish, and butterfish, 1976 - 1983.

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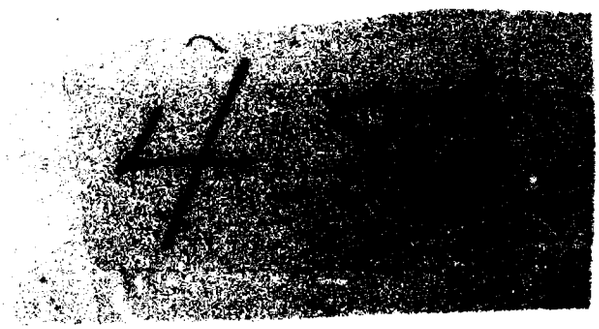

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